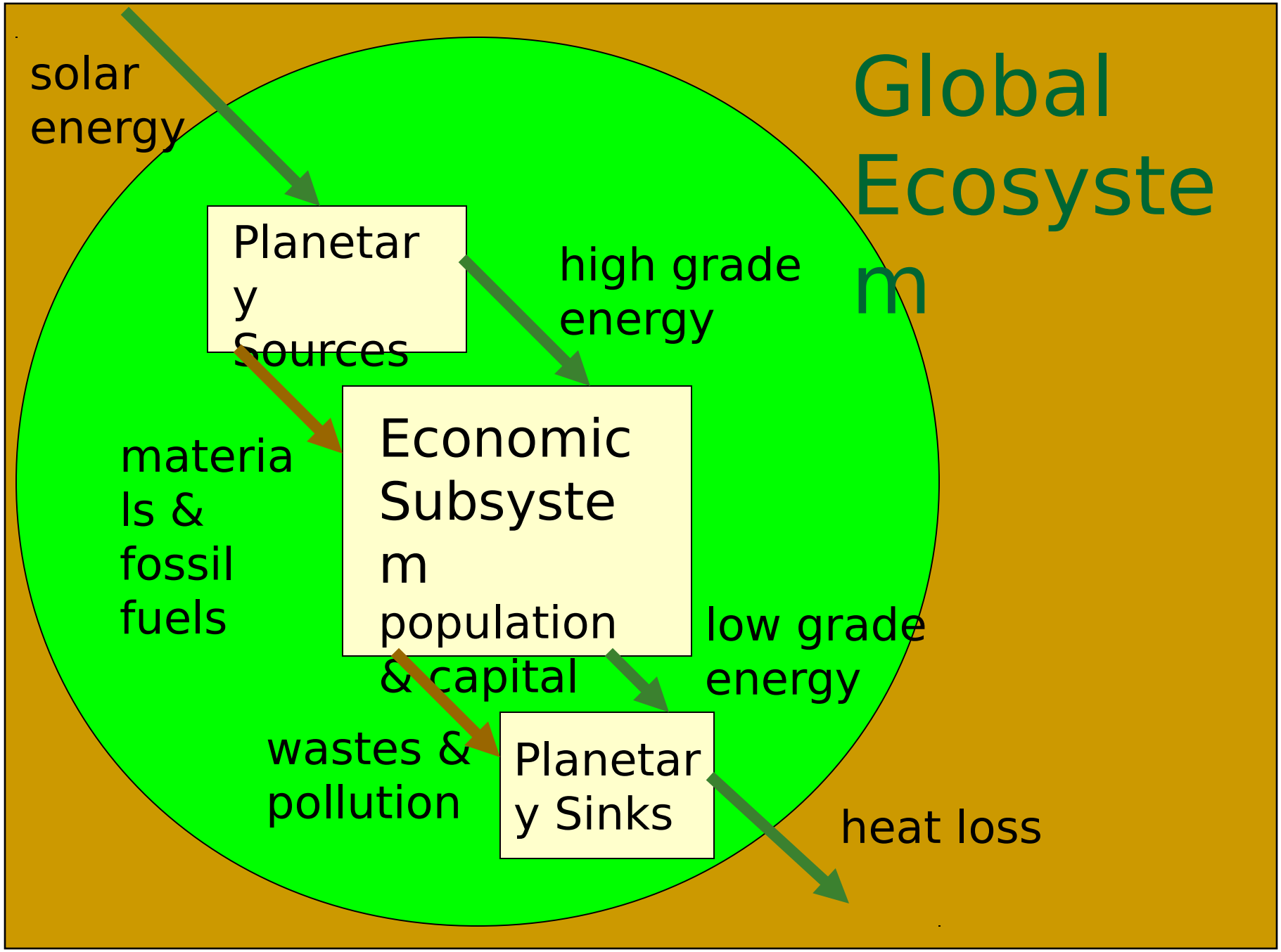
Introduction to Sustainability


solar energy
Global Ecosystem
Planetary Sources
high grade energy
materials & fossil fuels
Economic Subsystem
population & capital
low grade energy
wastes & pollution
Planetary Sinks
heat loss

Natural Capital

Definition: the stocks and flows in nature from which the human economy takes its materials and energy (sources) and to which we throw those materials and energy when we are done with them (sinks).

Examples of Natural Capital/Services

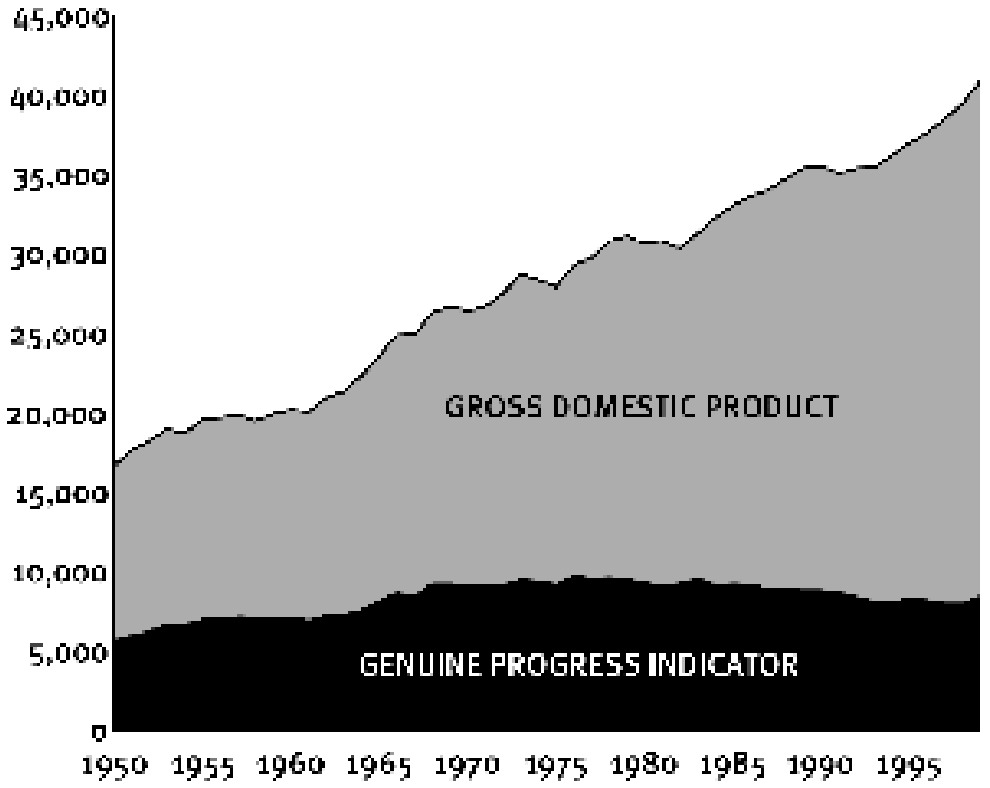
- Climate regulation
- Water regulation
- Water supply
- Erosion control
- Soil formation
- Biological control
- Recreation
- Refugia
- Gas regulation
- Disturbance regulation
- Nutrient cycling
- Waste treatment
- Pollination
- Food production
- Raw Materials
- Genetic Resources

Natural Capital

- The value of the goods and services provided by nature is estimated at $40 trillion/year.
- In many cases there is little relation between the value of services and observable current spending behavior.
- Also there is no relationship between the valuation of natural capital flows and aggregate spending in the GDP.
- Paradoxically, natural capital, the basis for our economy, is not part of the current economic system .

Genuine Progress Indicator

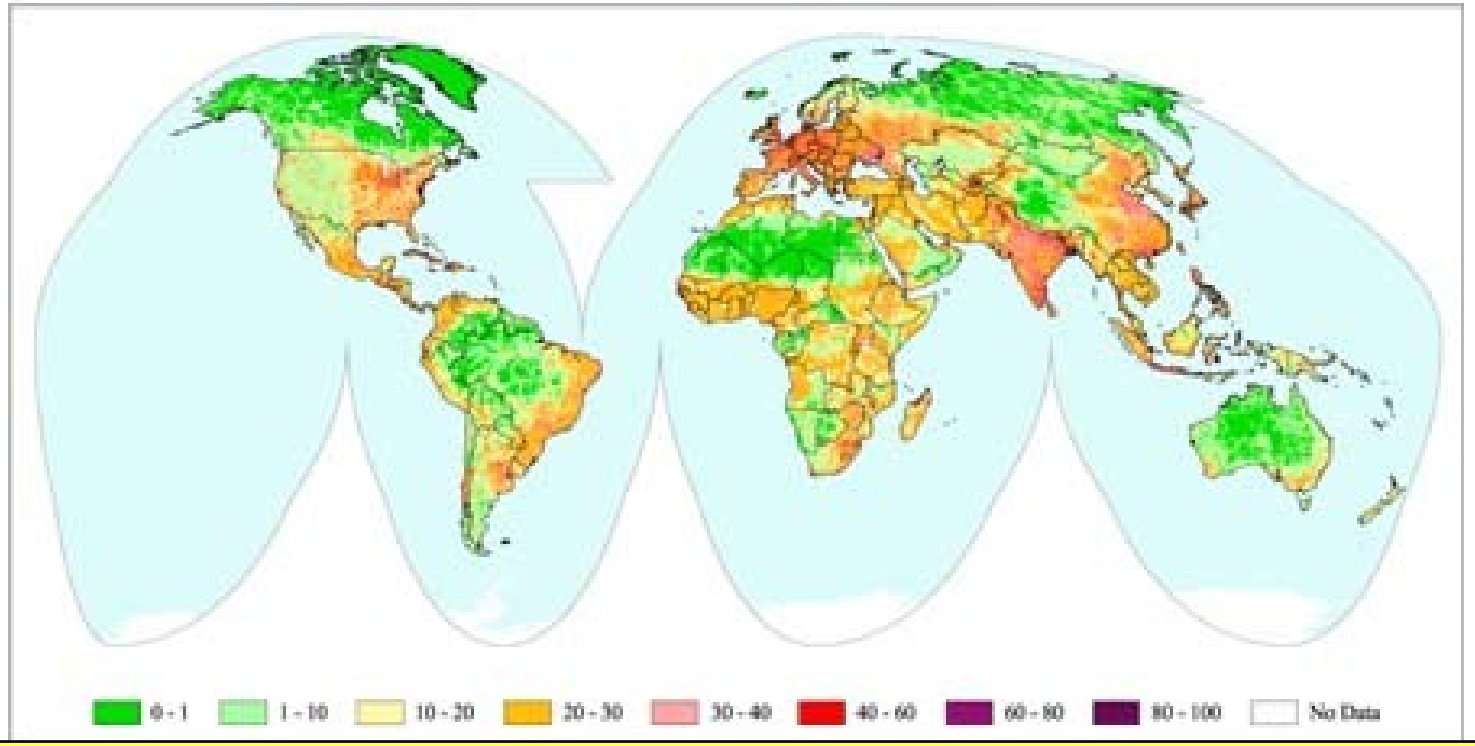
- Adjusts GDP for:
  - Household and volunteer work
  - Pollution
  - Crime
  - Family breakdown
  - Depletion of non-renewable resources
  - Long-term environmental damage



Symptoms of Non-Sustainability (depletion of natural capital or disruption of natural services)

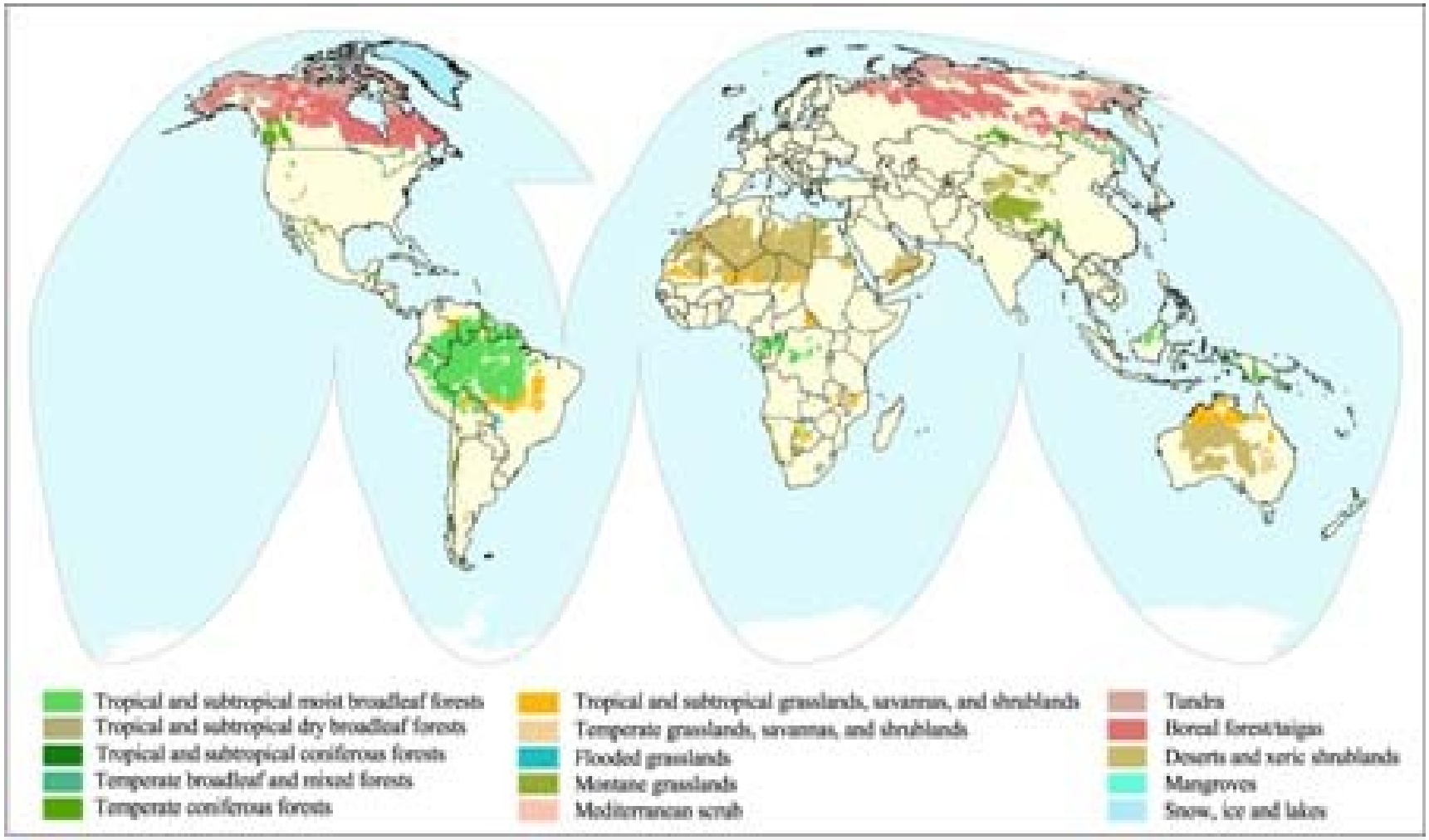
- Greenhouse effect and climate change
- Ozone depletion
- Atmospheric acidification
- Toxic pollution
- Biological species extinction
- Deforestation
- Fisheries depletion
- Land degradation and desertification
- Depletion of non-renewable resources like fossil fuels, top soil, and minerals
- Urban air pollution and solid wastes

Human Footprint on the Earth



Analysis of the human footprint map indicates that 83% of the land's surface is influenced by one or more of the following factors: human population density greater than 1 person per square kilometer, within 15 km of a road or major river, occupied by urban or agricultural land uses, within 2 km of a settlement or a railway, and/or producing enough light to be visible regularly to a satellite at night. 98% of the areas where it is possible to grow rice, wheat or maize (according to FAO estimates) are similarly influenced.

The Remaining Wild Places



The Message of the Human Footprint and the Last of the Wild

- The human footprint is a global driver of conservation crises on the planet.
- If we want to conserve wildlife and wild places and have a rich and beautiful environment for ourselves, we need to find ways to moderate the negative impacts of human influence, while enhancing the positive impacts.
- Part of the solution is conserving the Last of the Wild -- those few places, relatively less influenced, by human beings, in all ecosystems around the globe.
- Part of the solution is becoming better stewards of Nature across the gradient of human influence through conservation science and action.
- But the most important part of the solution is for human beings, as individuals, institutions and governments, to choose to moderate their influence in return for a healthier relationship with the natural world.

What is sustainable design and development?

Our Common Future

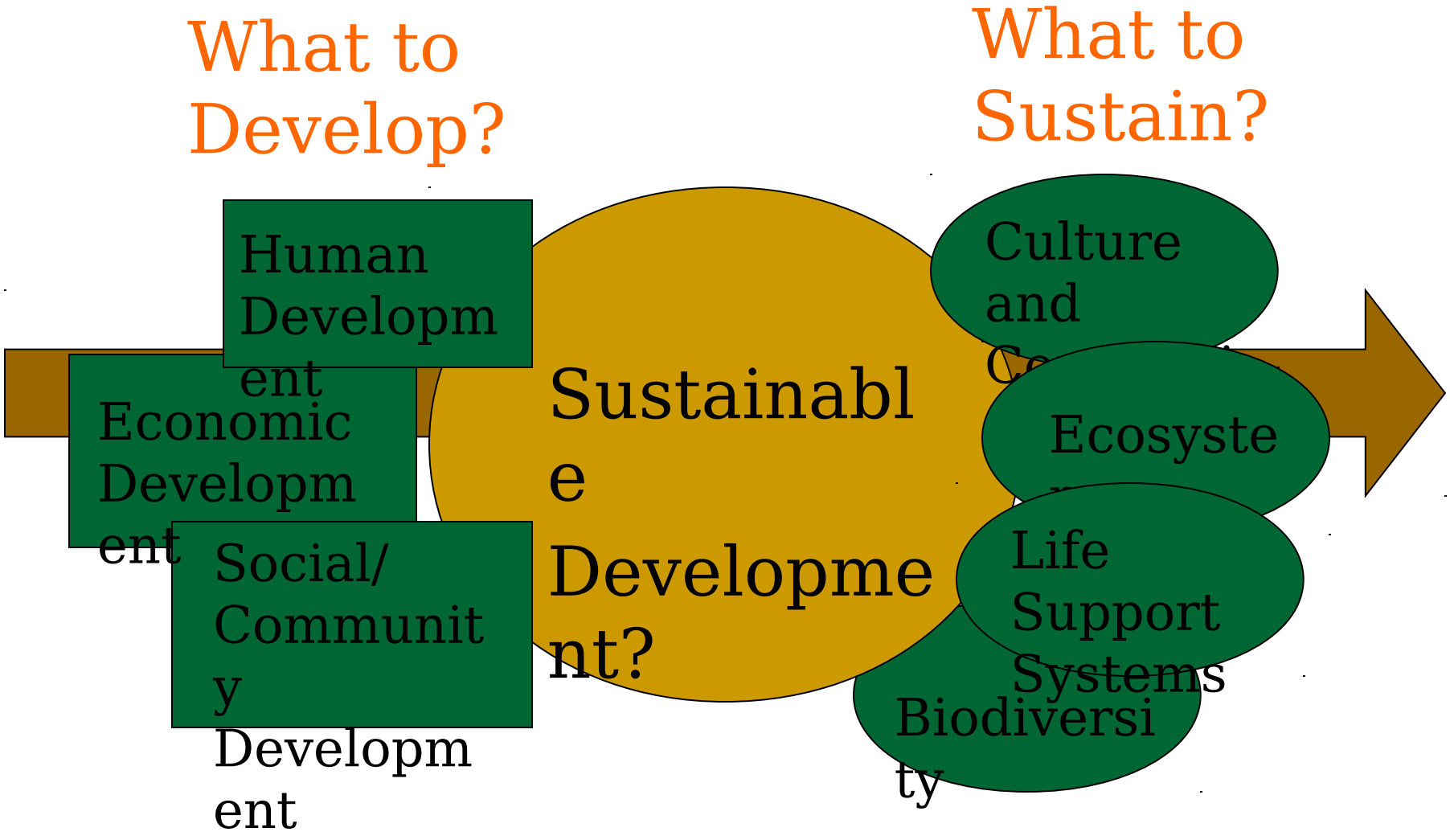
- The Brundtland Commission

  (Our Common Future, 1987)

  - Poorest 20% of the worlds population consume 2% of the global economic product
  - Richest 20% of the worlds population consume 75% of the global economic output
  - 26% of the global population consumes:
    - 80-86% of all non-renewable resources
    - 34-53% of all food products
  - Defined sustainable development:

Meeting the needs of the present and without compromising the ability of future generations to meet their own needs

Sustainable Development



Sustainable Design and Development

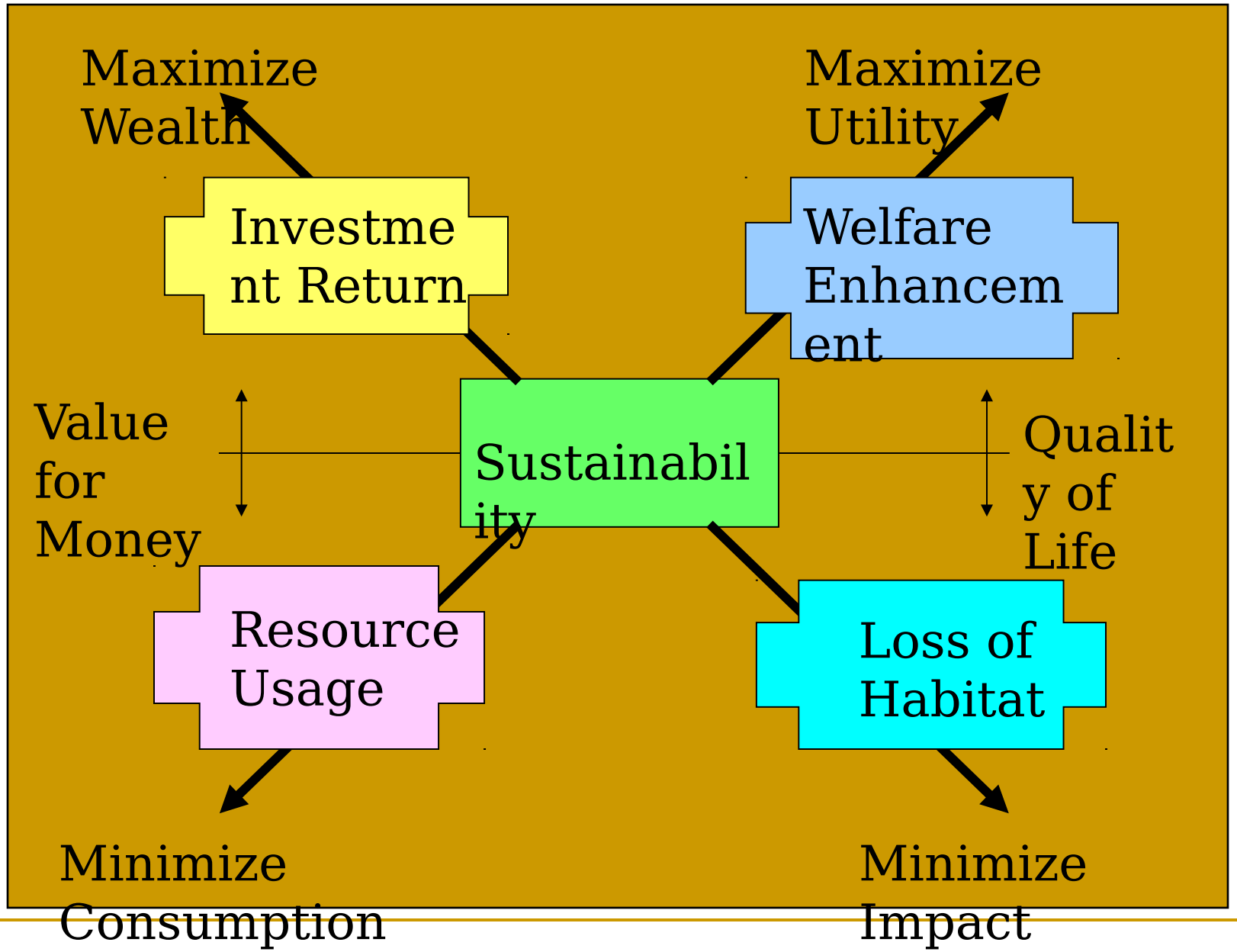
- Environmental issues are moving into the mainstream.
- Sustainable Design can lead us to new buildings that are healthy, productive, and enhance our quality of life.
- Many options and opportunities are available today and are being incorporated into new and existing buildings and into communities.

Ten Simple Things To Do

- Select and develop sites to promote livable communities.
- Develop flexible designs to enhance building longevity.
- Use environmentally preferable building materials – natural and local.
- Use appropriate plant material.
- Plan for recycling during construction, occupancy, and demolition.

Ten Simple Things To Do

- Use natural strategies to protect and restore water resources.
- Conserve water and consider water reuse systems.
- Improve energy efficiency while ensuring thermal comfort.
- Reduce environmental impacts related to energy use.
- Promote health and well-being in the indoor environment.


Maximize Wealth
Maximize Utility
Investment Return
Welfare Enhancement
Value for Money
Sustainability
Quality of Life
Resource Usage
Loss of Habitat
Minimize Consumption
Minimize Impact

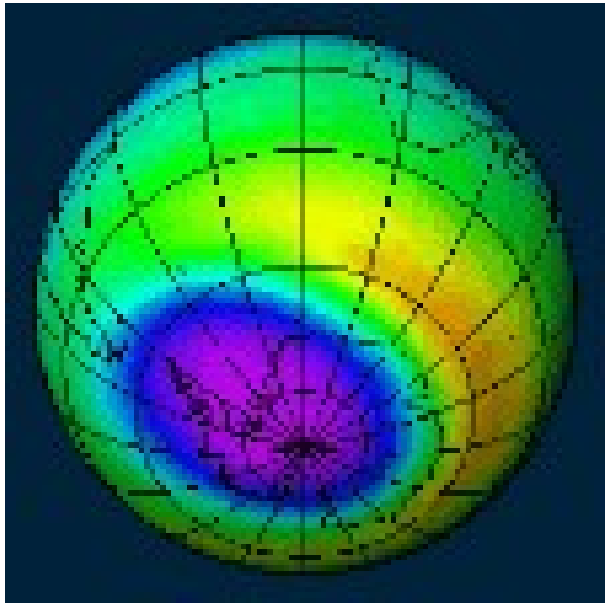
Why do we need sustainable designs?

Our Interaction With the Earth

- Tropical forests are shrinking by 11 million hectares per year; 31 million hectares of forest cover in industrial countries have been damaged, apparently by air pollution or acid rain.
- An estimated 26 billion tons of topsoil are lost in excess of new soil formation annually.
- Some 6 million hectares of new desert are formed annually by land mismanagement.
- Thousands of lakes in the industrial north are now biologically dead; thousands more are dying.
- Underground water tables are dropping in parts of Africa, China, India, and North America as demand for water rises above aquifer recharge rates.

Our Global Environment

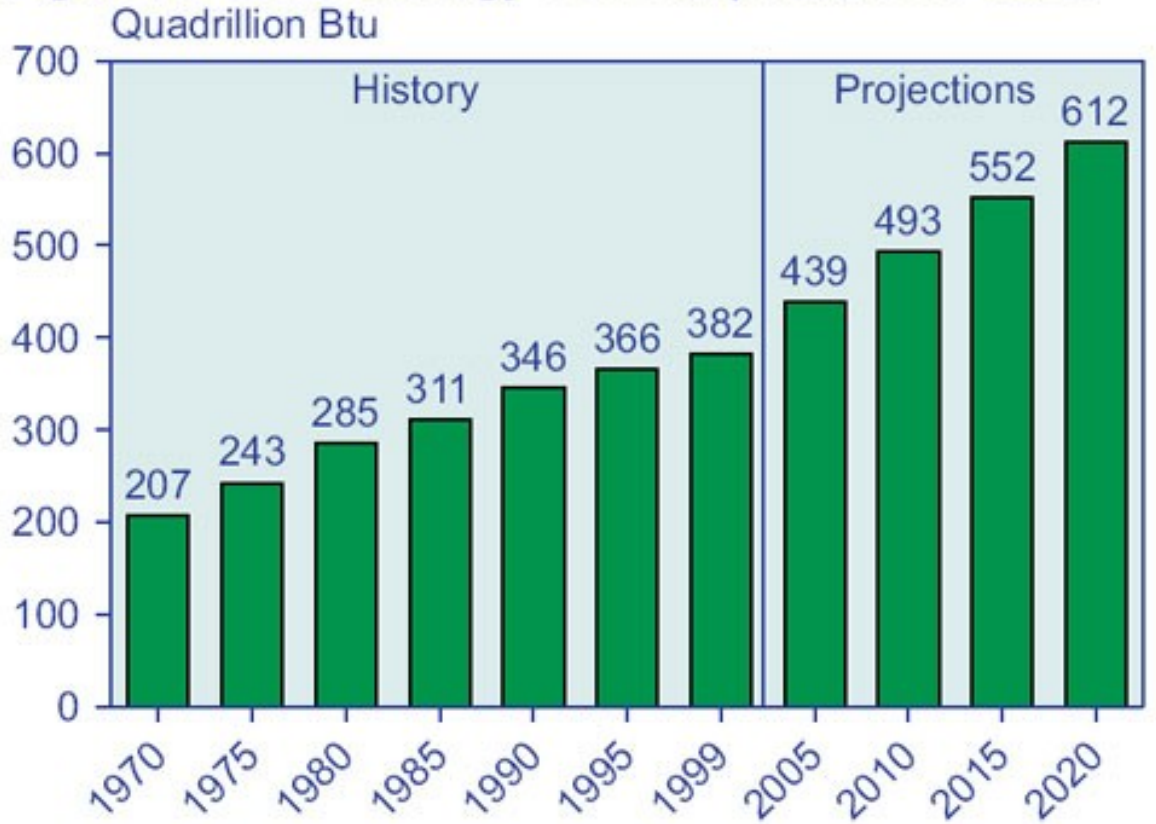
- Extinctions of plant and animal species are now estimated at several thousand per year; one-fifth of all species may disappear over the next 20 years.
- Some 50 pesticides contaminate groundwater in 32 American states; some 2,500 U.S. toxic waste sites need clean-up; the extent of toxic contamination worldwide is unknown.
- The growing hole in the ozone layer over Antarctica each spring suggests a gradual global depletion could be starting (and now over the artic and some mid-latitudes).
- Global climate change brought on by greenhouse gases (more later).



World Energy Consumption

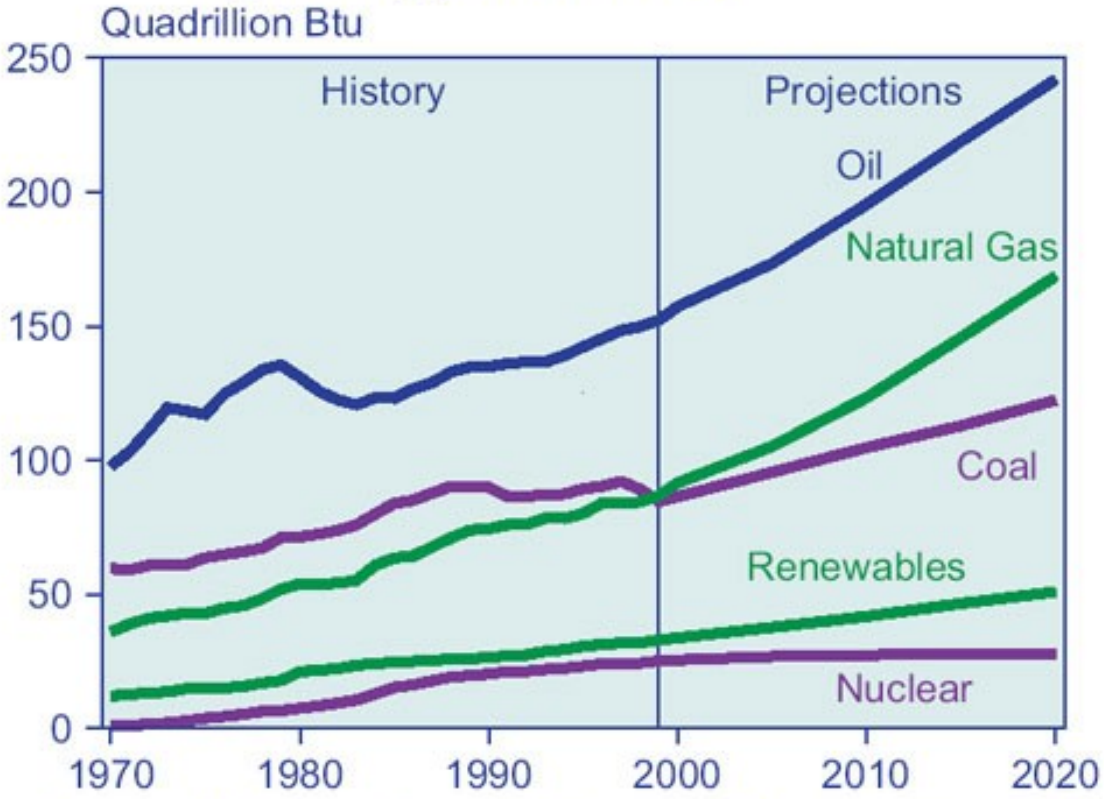
- United States, Russia, China, Japan, and Germany consumed half of the world's energy in 1997.
- United States, China, Russia, Japan, and India were responsible for half of the world's carbon dioxide emissions from the consumption of fossil fuels in 1997.
- Asia recorded the largest absolute increase in consumption between 1988 and 1997, 33 quadrillion British thermal units (Btu). This was more than double the increase of 16 quadrillion Btu for North America, the second largest regional increase in consumption
- Asia also had the largest absolute increase in energy production between 1988 and 1997, 22 quadrillion Btu. The Middle East had the second largest regional increase at 16 quadrillion Btu.

Figure 2. World Energy Consumption, 1970-2020



Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1999*, DOE/EIA-0219(99) (Washington, DC, February 2001). **Projections:** EIA, World Energy Projection System (2002).

Figure 6. World Energy Consumption by Fuel Type, 1970-2020



Sources: **History:** Energy Information Administration (EIA), Office of Energy Markets and End Use, International Statistics Database and *International Energy Annual 1999*, DOE/EIA-0219(99) (Washington, DC, February 2001). **Projections:** EIA, World Energy Projection System (2002).

2000 US Energy Flows

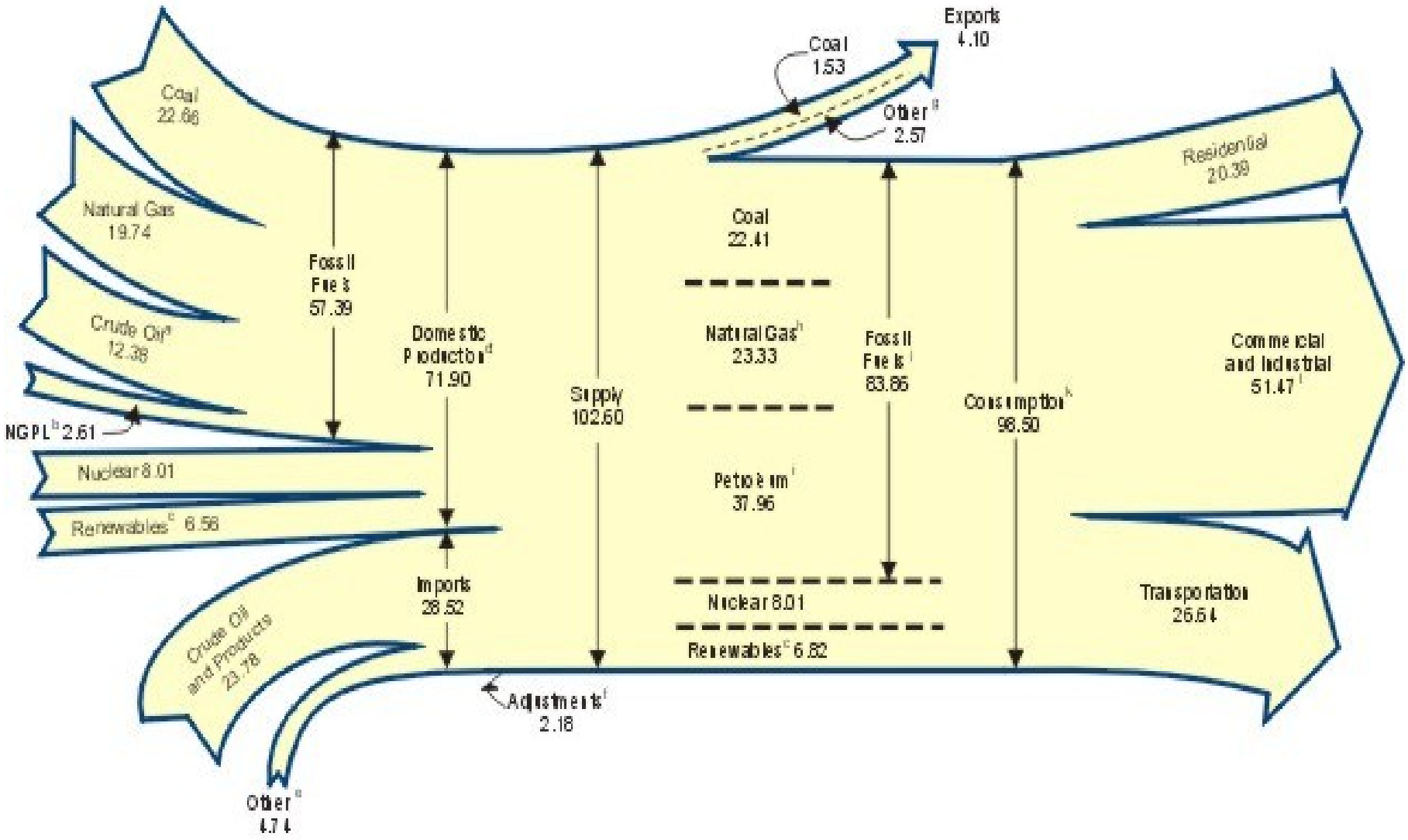


Figure 2. Energy consumption by fuel, 1970-2025 (quadrillion Btu)

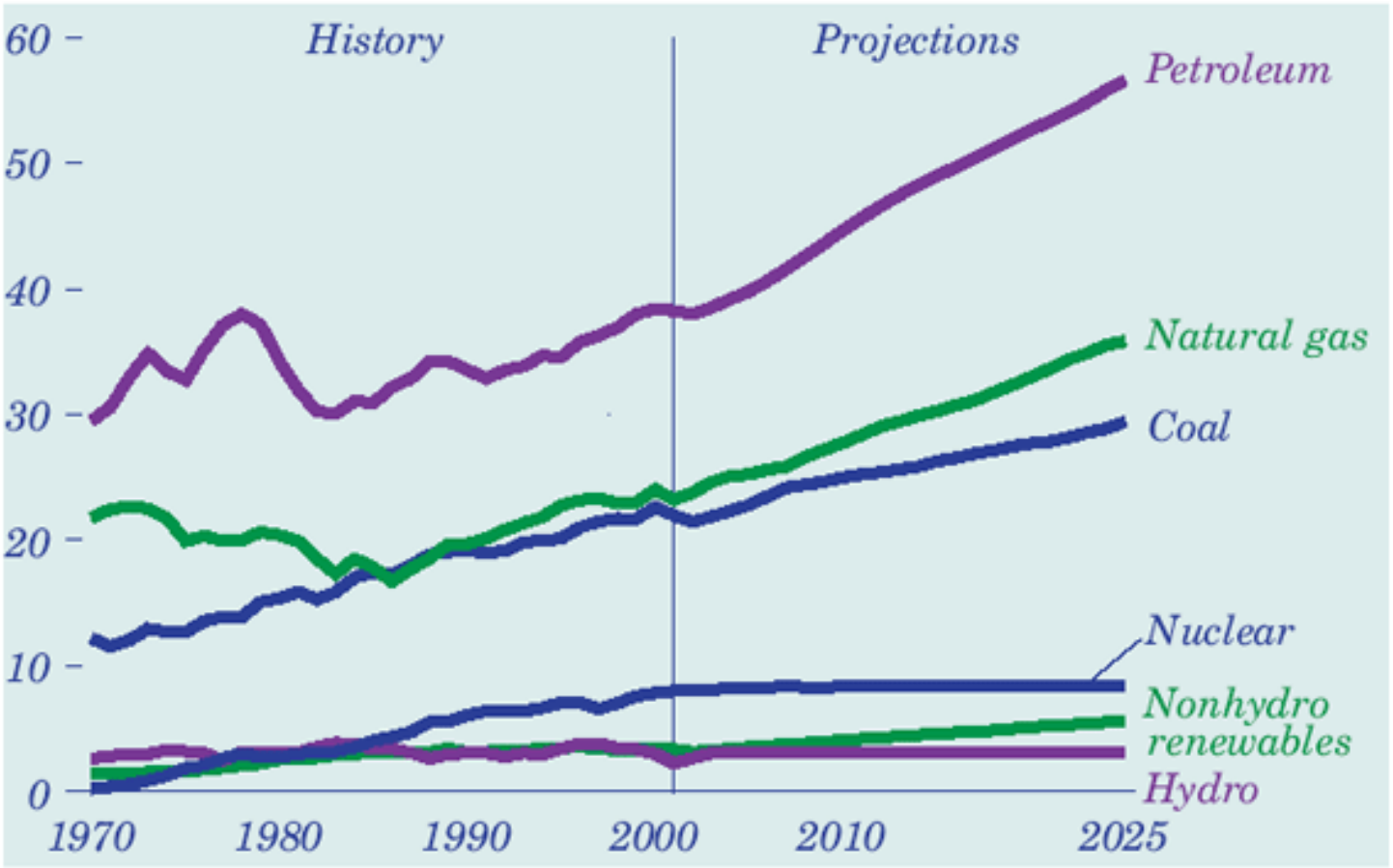


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Figure 5. Total energy production and consumption, 1970-2025 (quadrillion Btu)

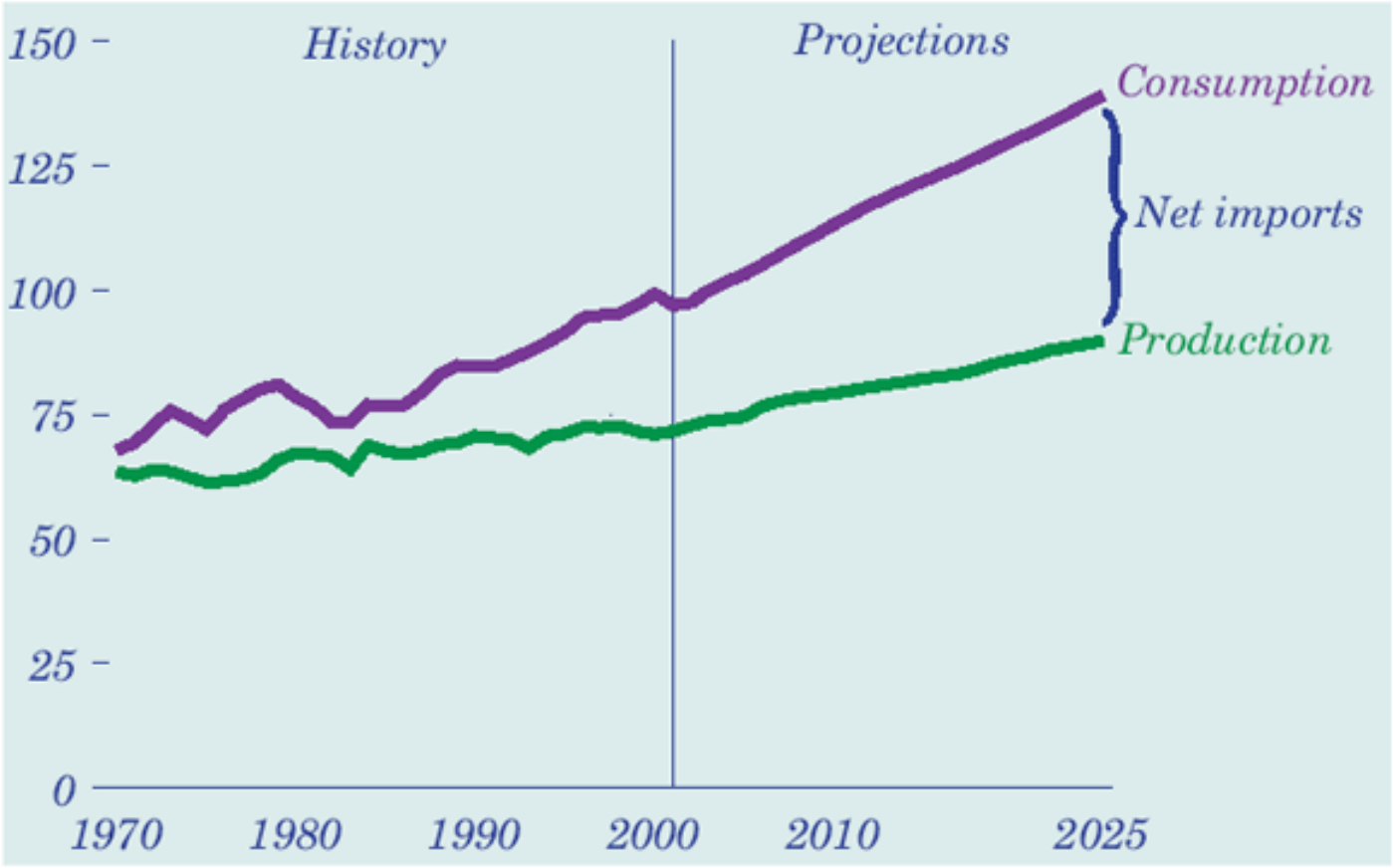

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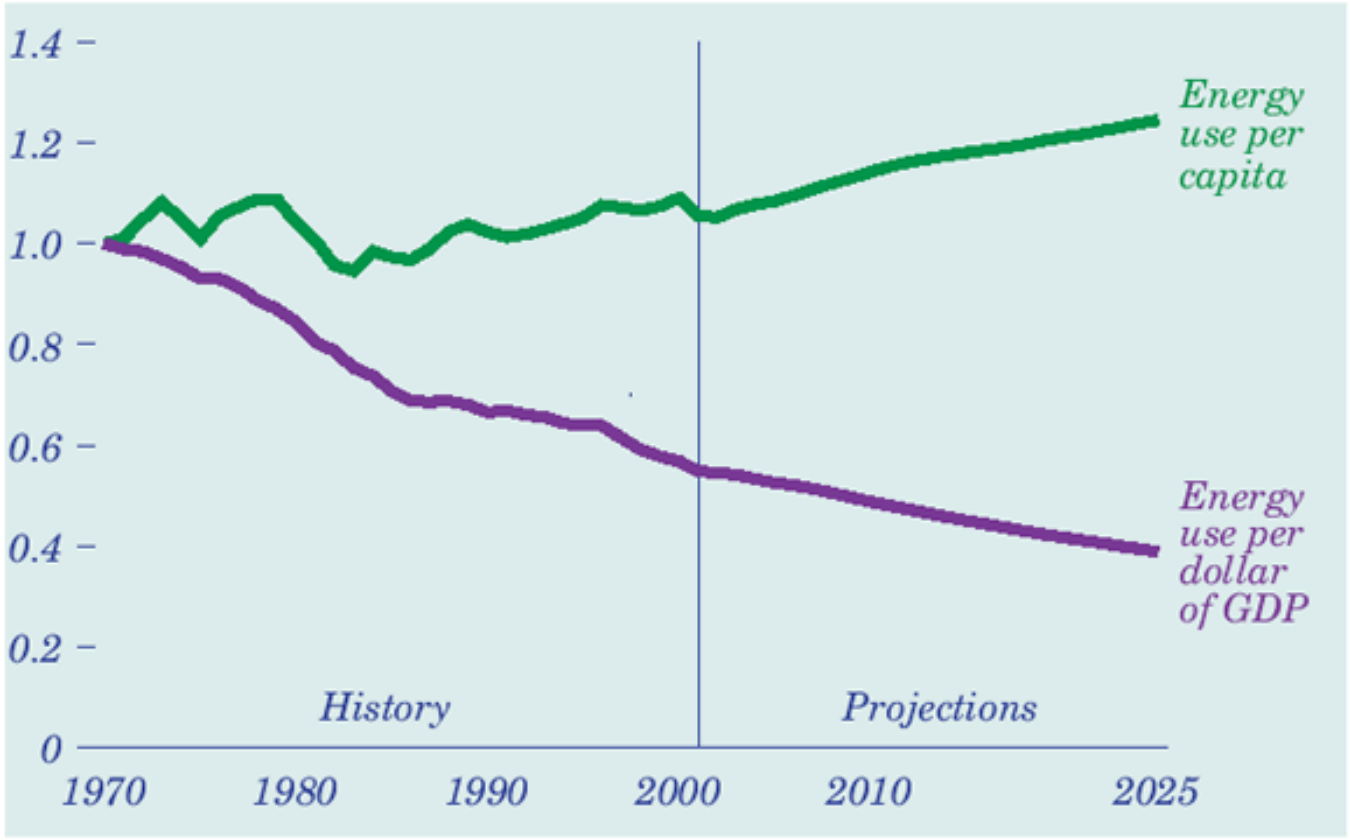
Figure 3. Energy use per capita and per dollar of gross domestic product, 1970-2025 (index, 1970 = 1)



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2000 US Electrical Energy Flows

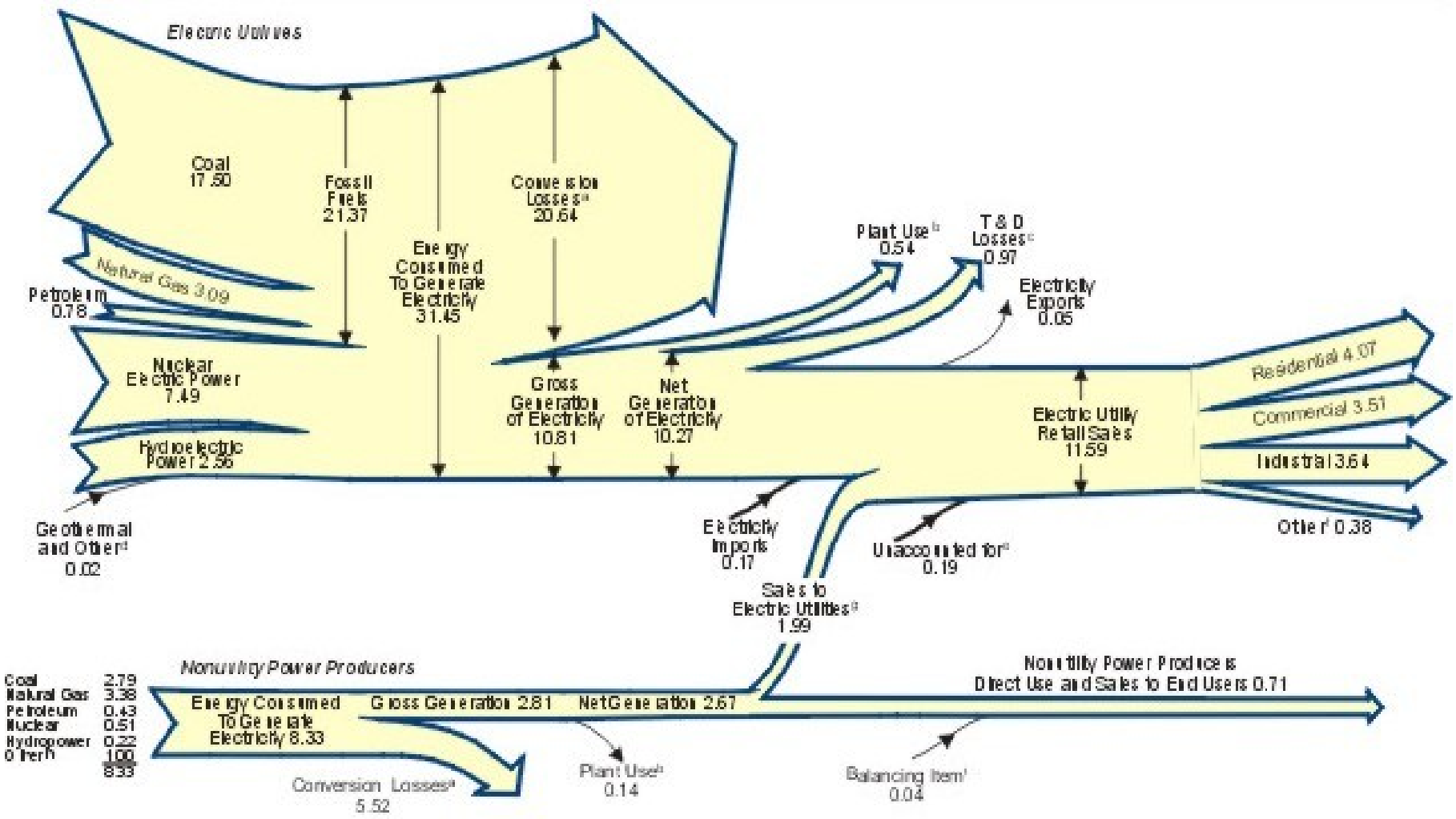
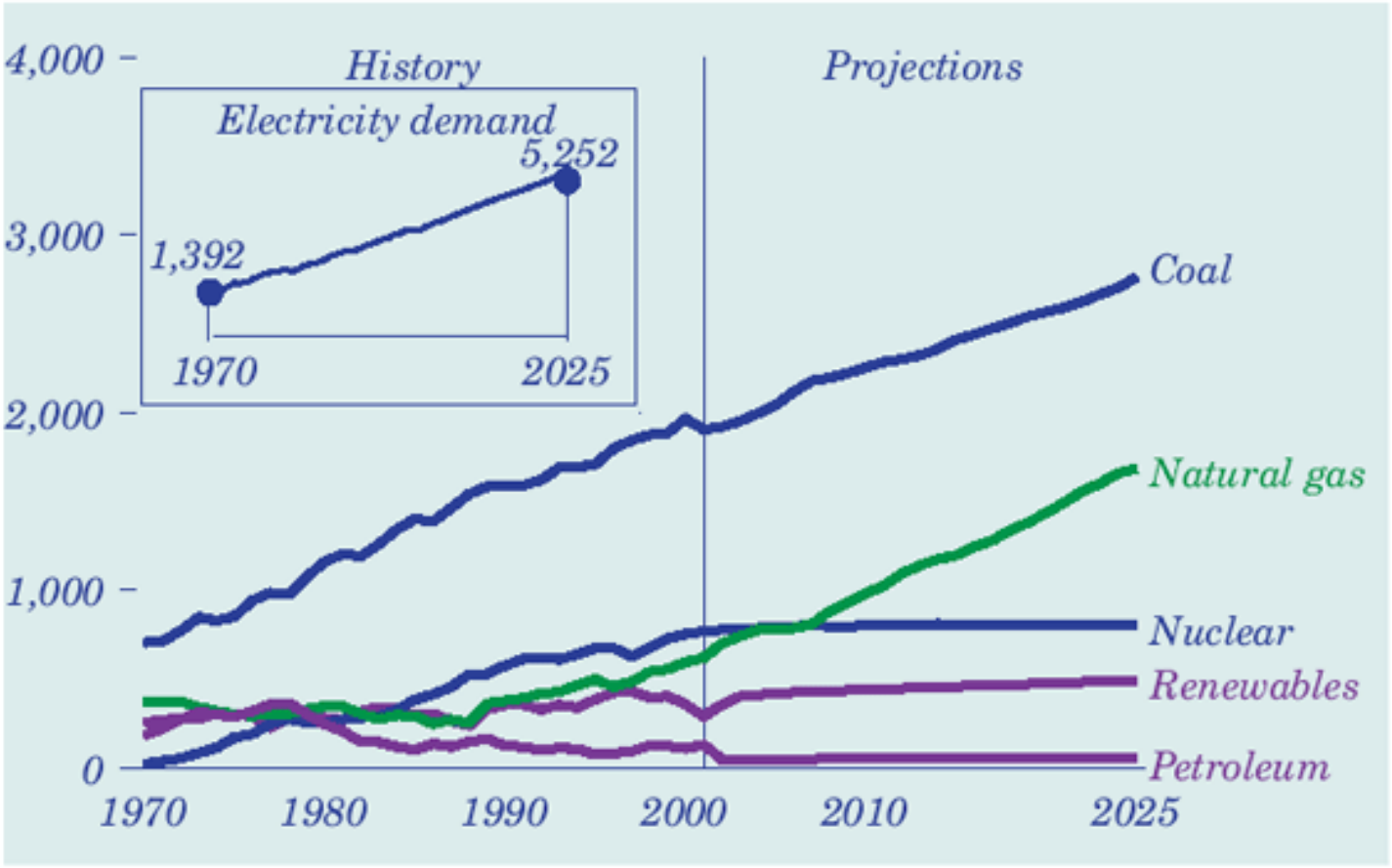


Figure 4. Electricity generation by fuel, 1970-2025 (billion kilowatthours)



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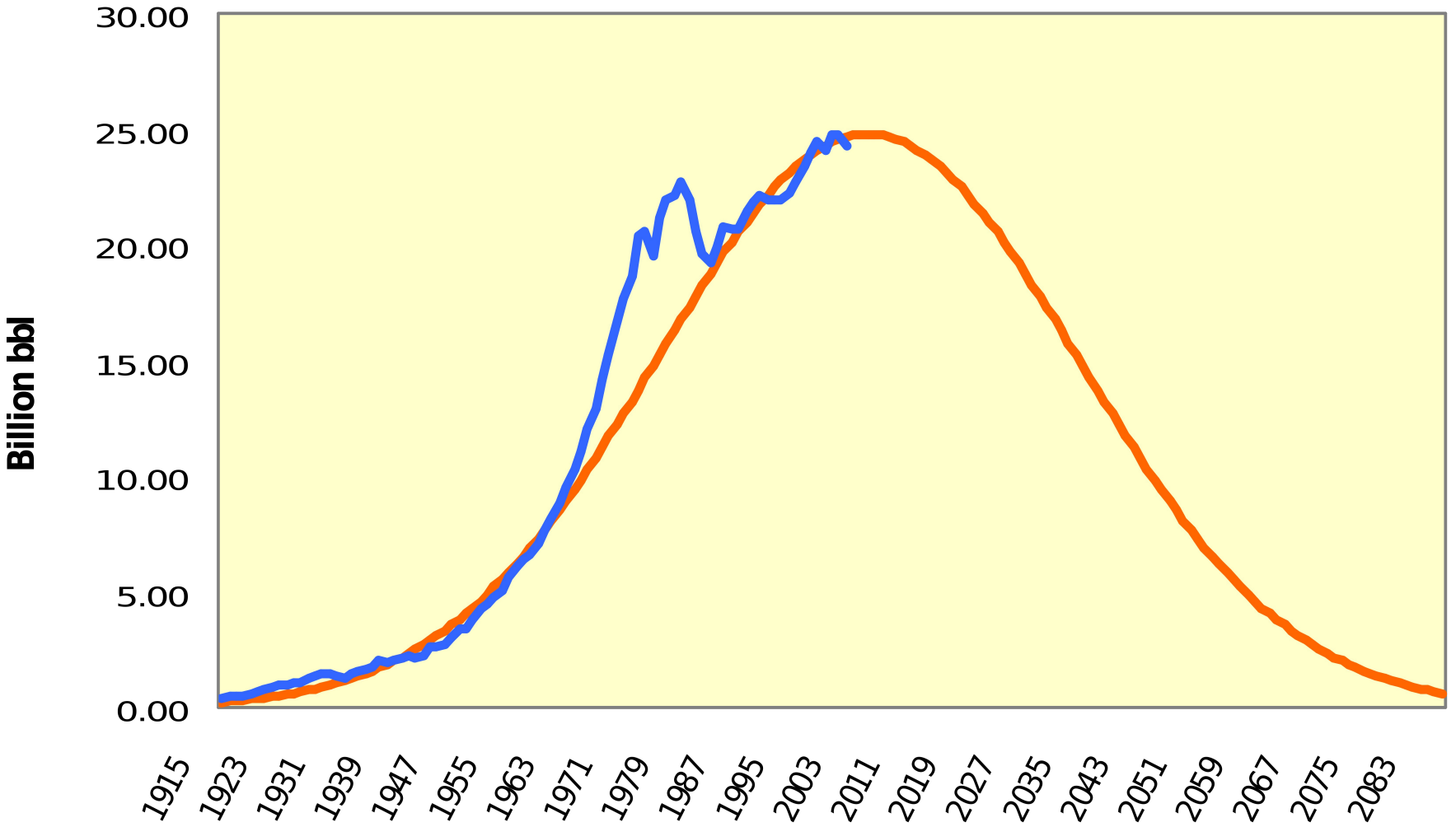
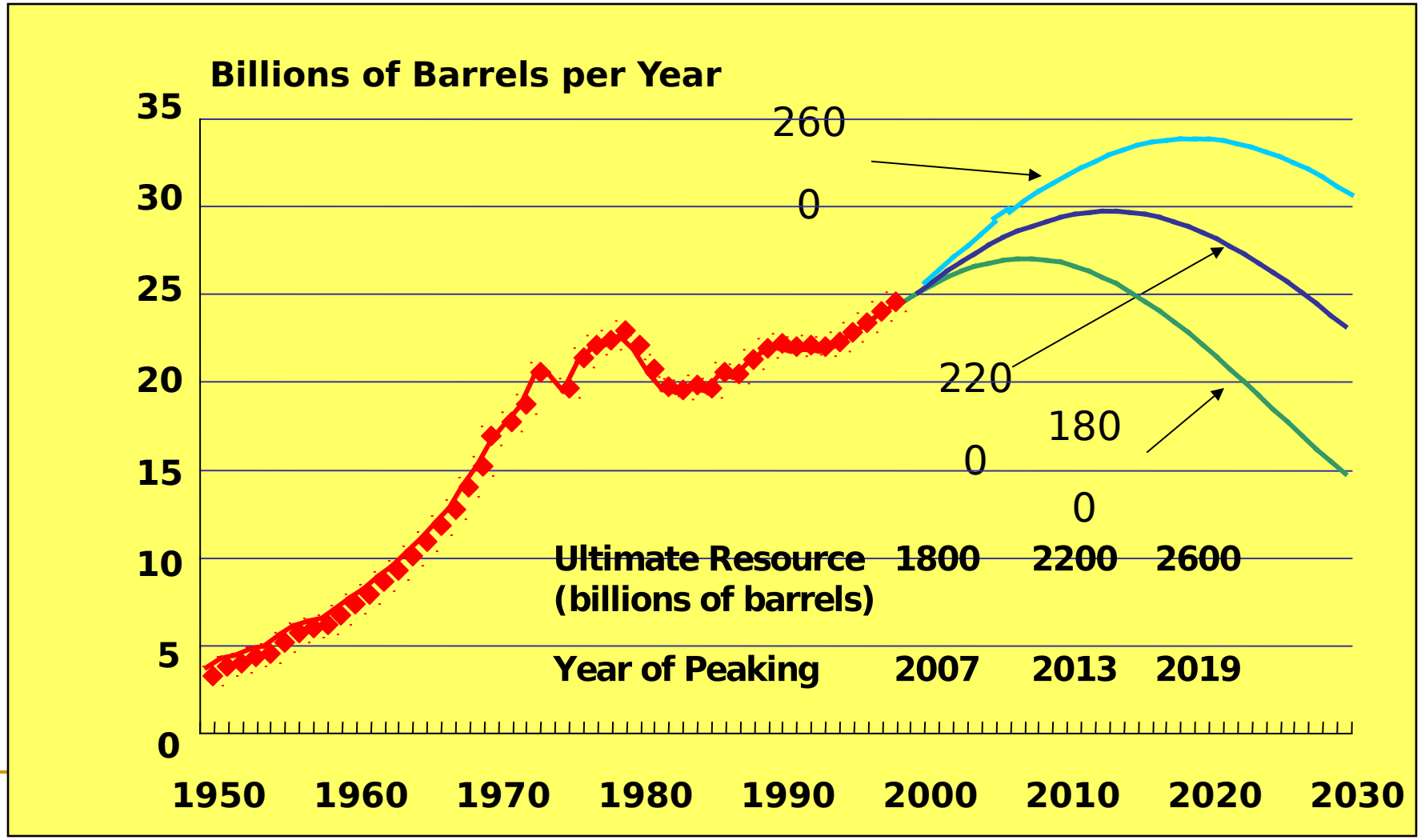
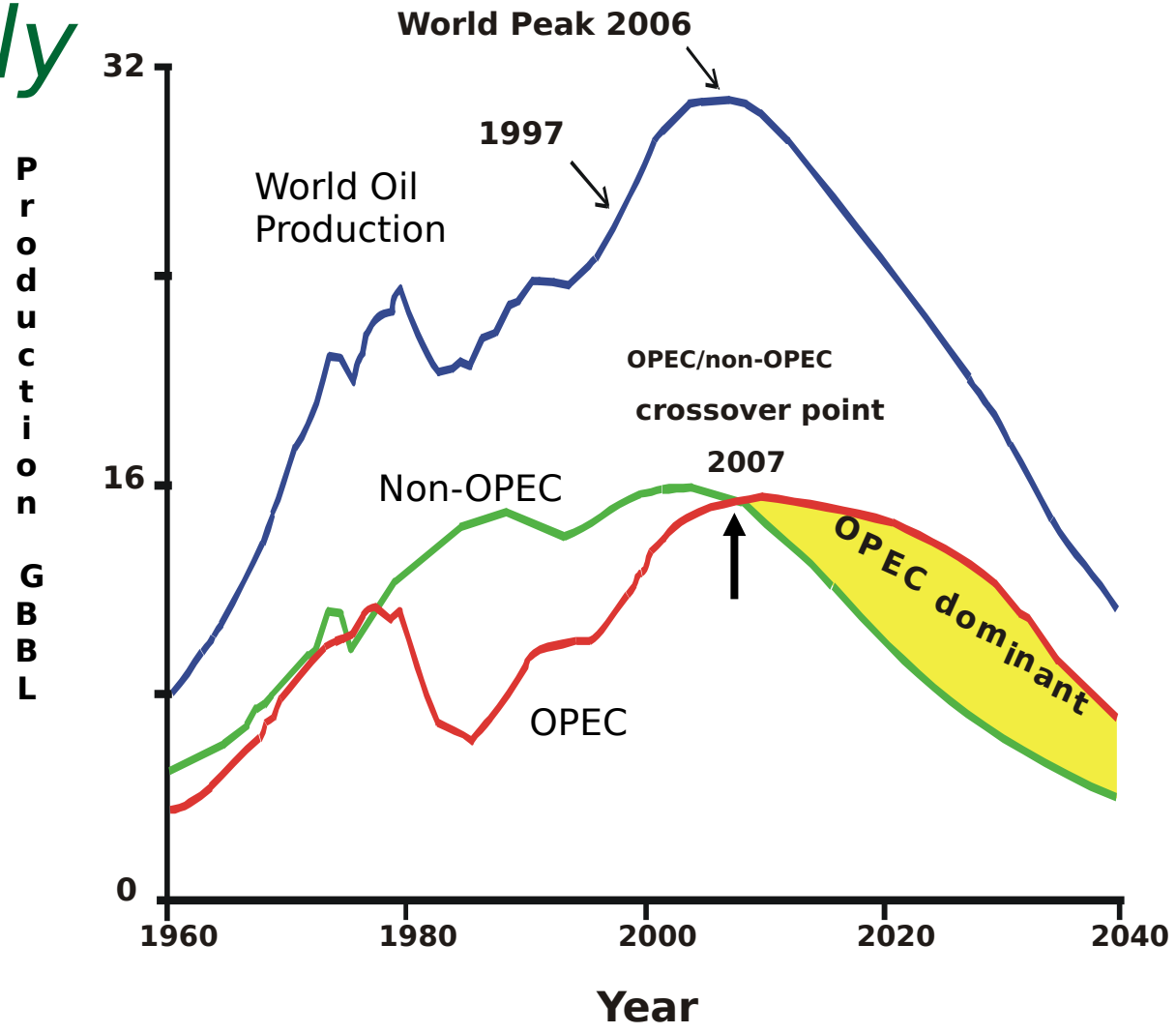
World Oil Production



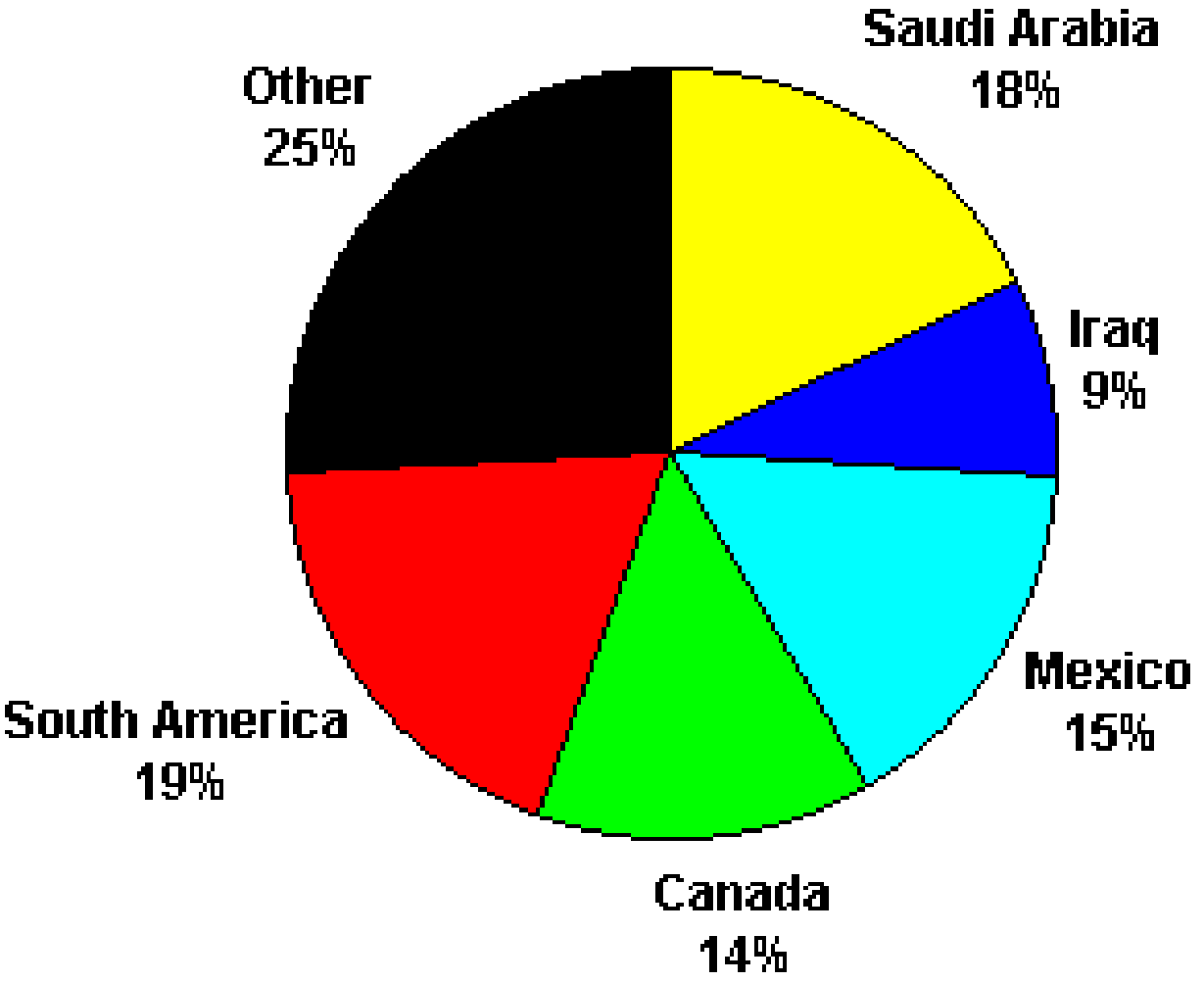
Global Oil Production for Resources of 1800,2200, and 2600 Billion Barrels



OPEC Dominance Expected Shortly



U.S. Crude Oil Imports by Country, 2001

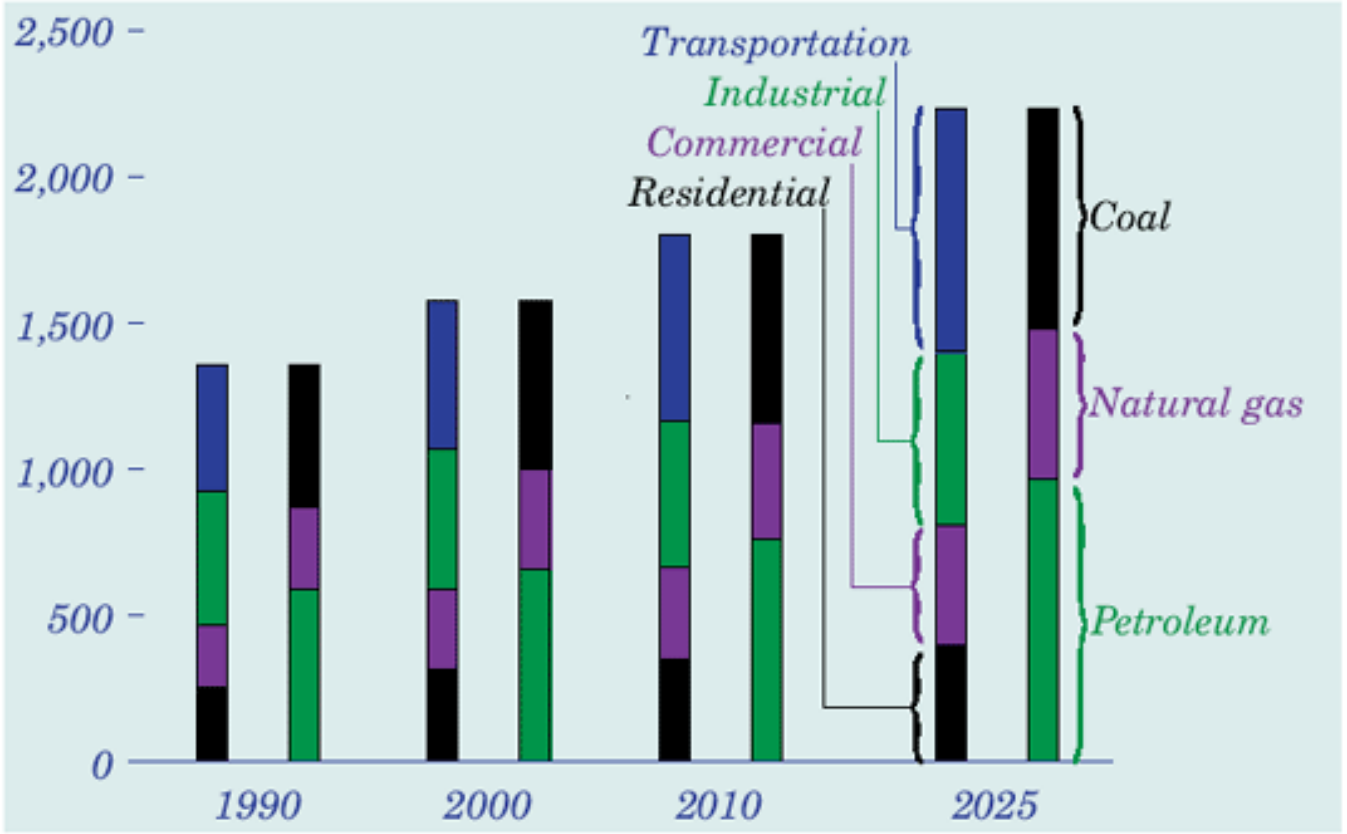


Source: EIA Weekly Outlook 4 April 2002

Caspian Region Oil Pipelines

Source: DOE/EIA-0484(98) World Energy Consump

Figure 7. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2025 (million metric tons carbon equivalent)



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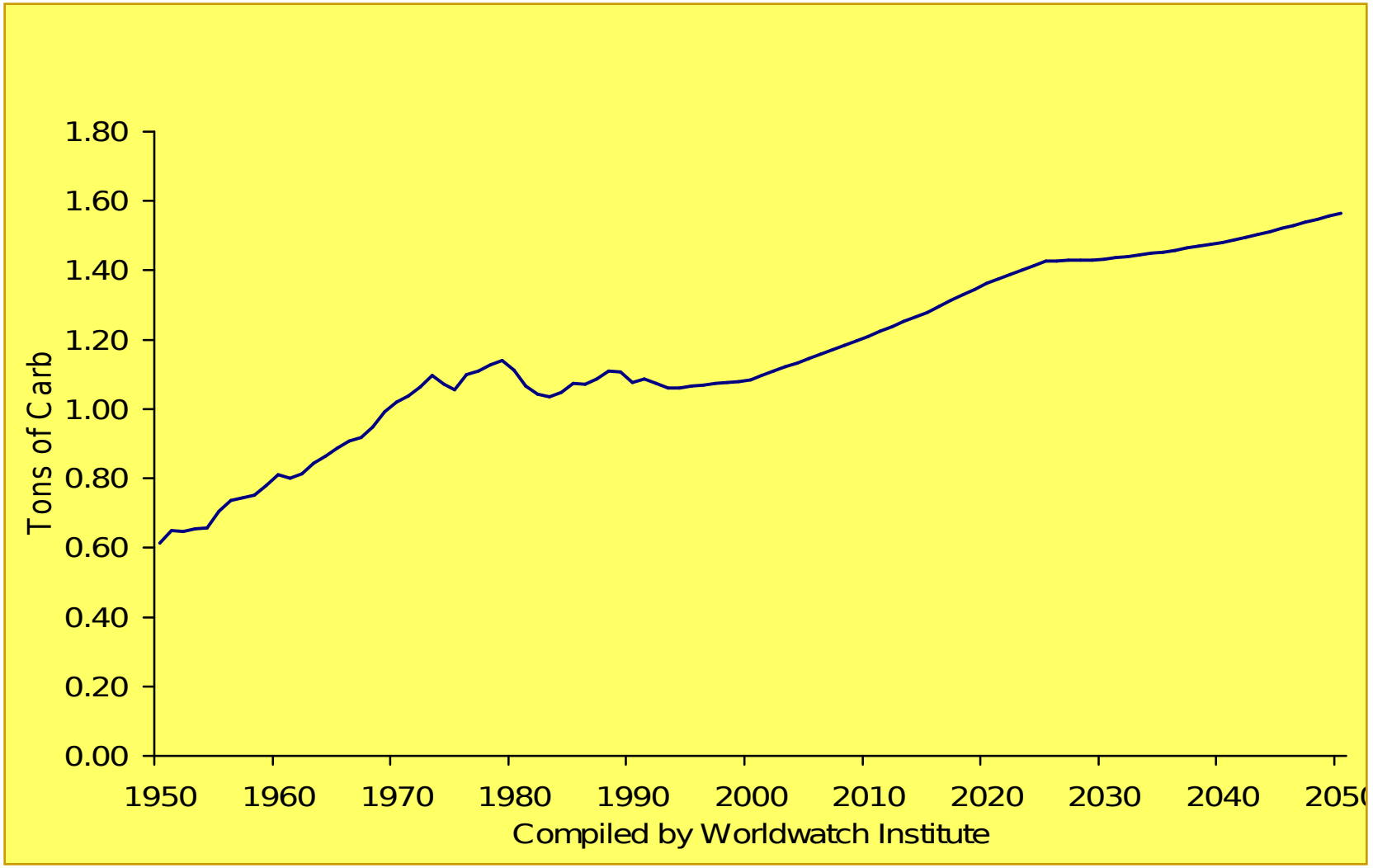
The Culprits

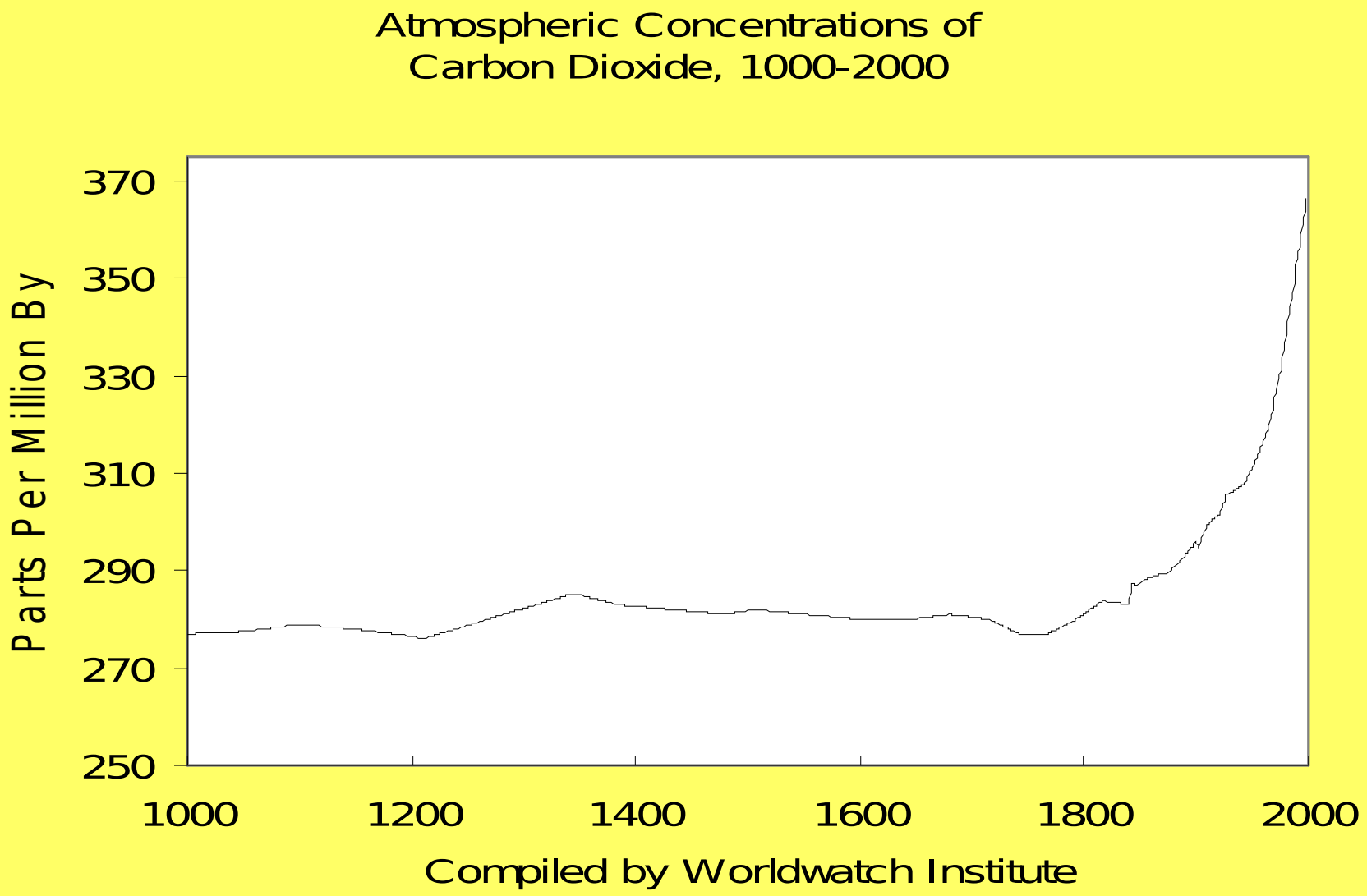
Coal-Fired Power Plant

Excursion Limited Ultimate with Optional Limited Premier Group in Aspen Green

Global Carbon Emissions/Person



Atmospheric CO_2



Global Climate Change

- The heat is on - climate change is real:
  - Antarctic temperatures up 20F - ice shelf melting.
  - Warmest 15 years in recorded history since 1980.
  - Nine hottest years on record since 1990.
  - Hottest year in recorded weather history was 1998 (previously it was 1997, 2000 6th hottest, 2002 on track to break the record).
  - Atlantic Ocean rising 1/10 inch per year
  - Weather events more severe and unpredictable
- Cause is combustion of fossil fuels along with deforestation and dessertification

The Alaskan Columbia Glacier: on the verge of collapse?

Alaskan glacier melt responsible for about 9% of total sea rise in last 50 years – losing 2 m thickness per

Climate Change: Real or not?

- Pacific zooplankton declined 70% in last 20 years due to 2-3^{o}F rise in temps over last 4 decades.
- Coral reefs dying.
- Spring comes one-week earlier in Northern Latitudes than 20 years ago.
- Ice cover comes 1 month late and leaves 1 month early in Canada (polar bears are in real trouble).
- Glaciers are melting at historic rates.
- Arctic ice shelf has lost 40% of its thickness in the last 40 years.

Climate Change: Real or not?

- Arctic warming revealed by soil temps 4-7◦F higher during this century and by surface temps 10◦F higher since 1968.
- Old and new diseases spreading (malaria, dengue fever, cholera, yellow fever, hantavirus, & encephalitis).
- 300M people made homeless in 1998 by weather events and then there was Mitch in Honduras (1999), 25,000 dead in Venezuela (2000), Allison in Texas (2001).

Other Ecological Indicators

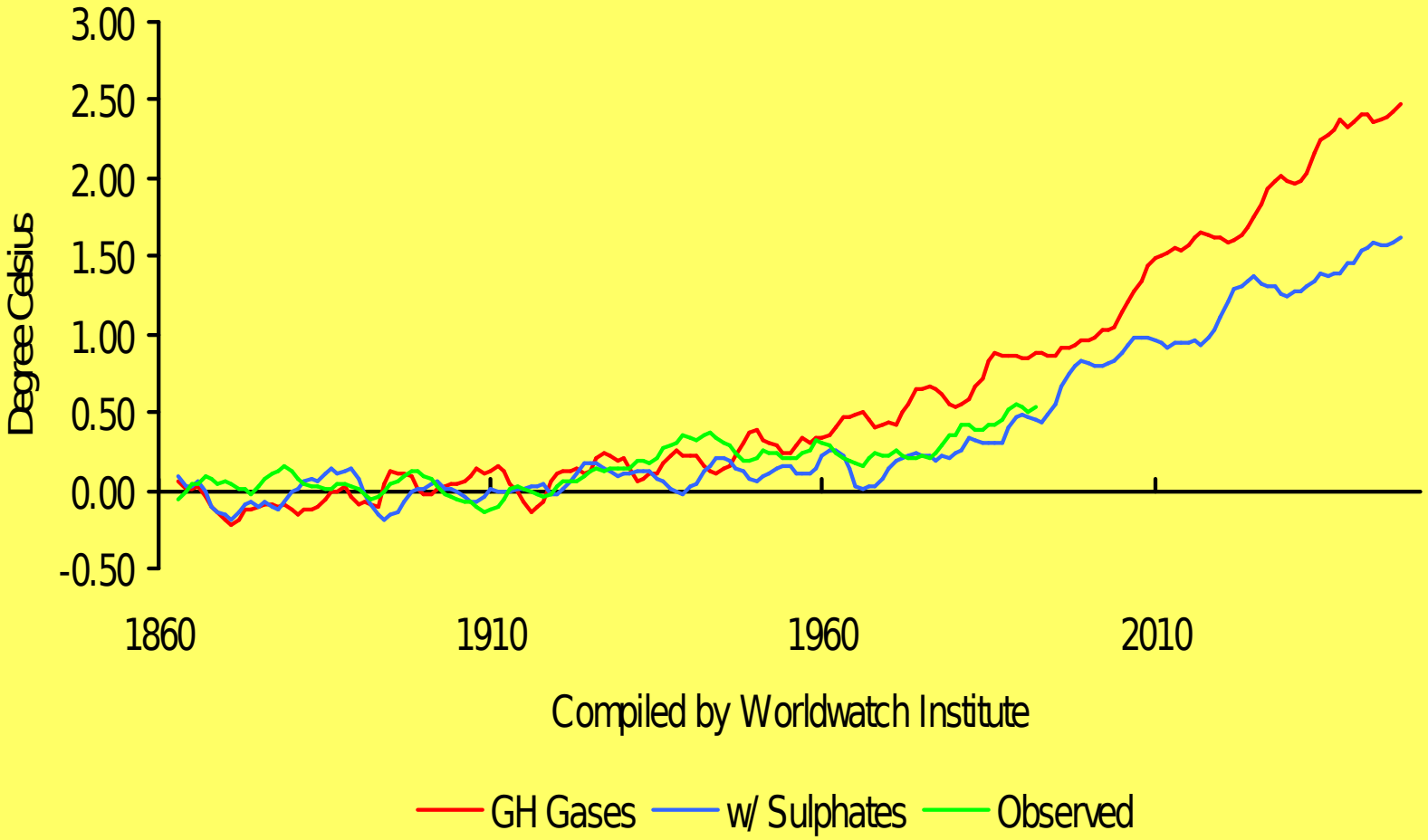
Human disruption of the Global Environment:

- Nitrogen fixation: HDI=1.5 (30% fossil fuels)
- Sulfur Dioxide: HDI=1.4 (85% fossil fuels)
- Carbon Dioxide: HDI=0.29 (75% fossil fuels)
- Methane in Atmosphere: HDI=1.1 (20% ff)
- Oil Added to Oceans: HDI=10 (60% oil harvesting, production, and transport)
- Particulate emissions: HDI=0.25 (35% ff)

HDI = Human-Alteration / Natural Stock

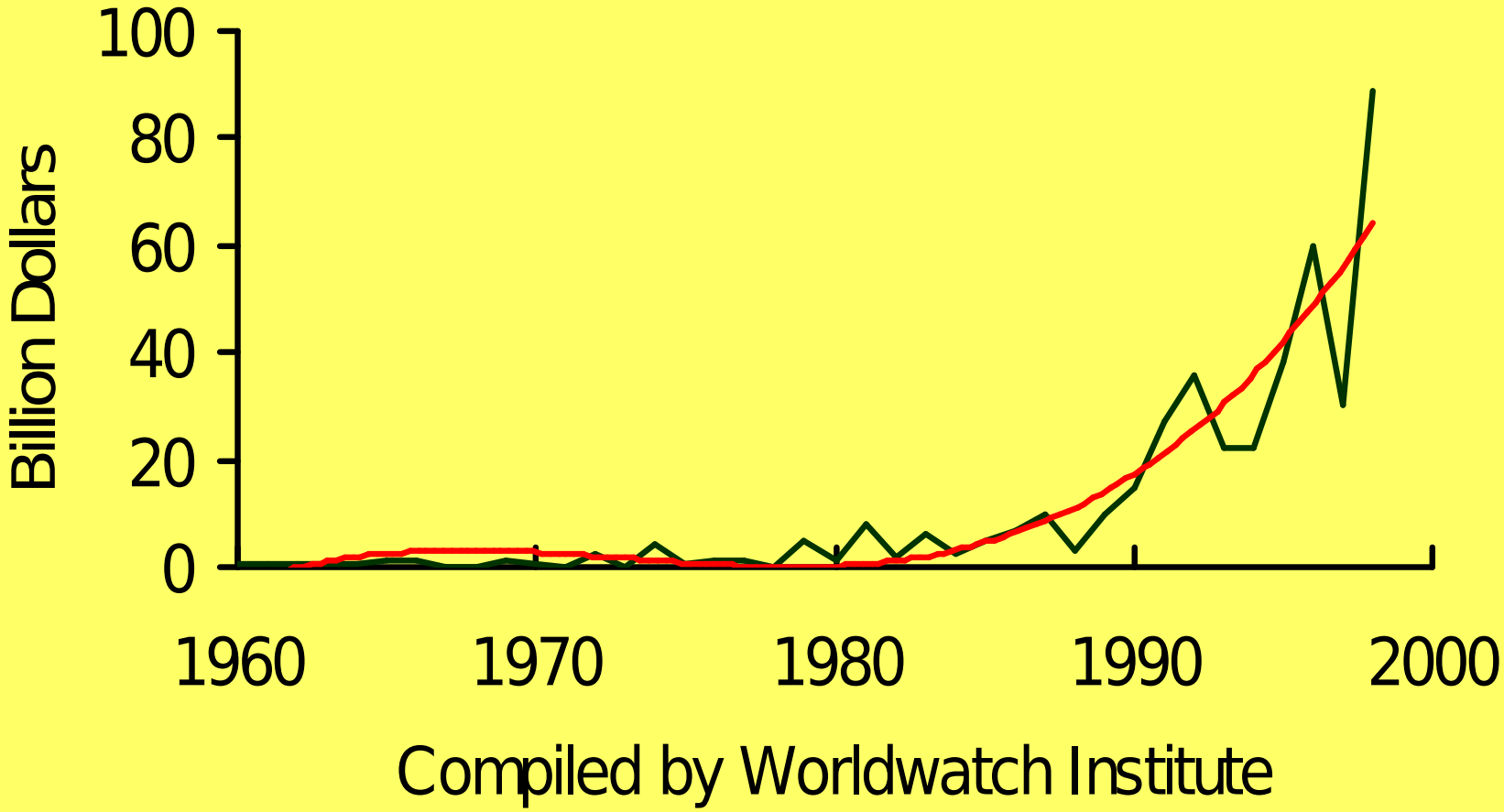
Global Warming

Models Compared With Observations, 1863-2047



Natural Disasters

Economic Losses Worldwide, 1960-98



Urban Sprawl

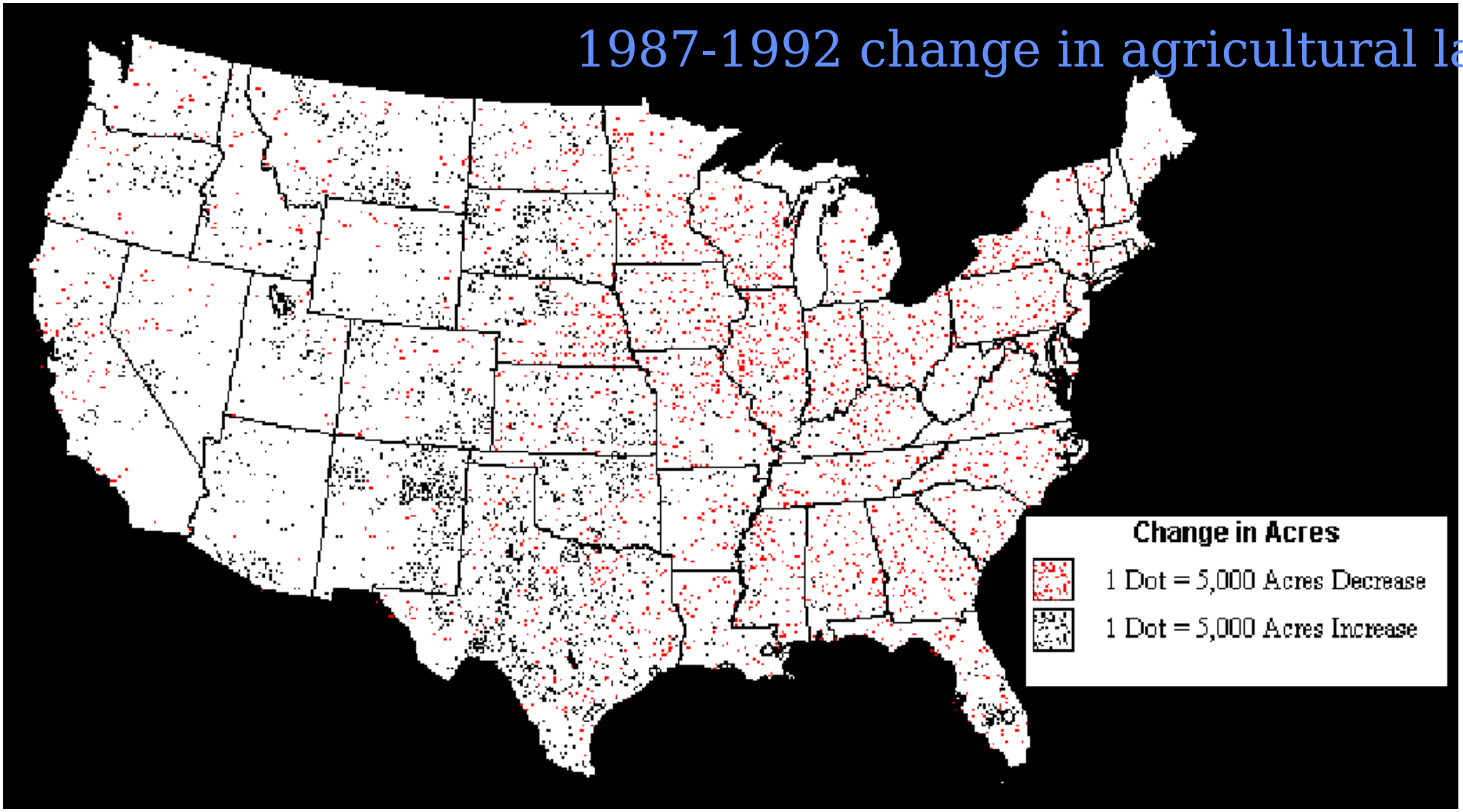
- Between 1982 and 1992, 4.3 million acres of prime farmland in the US were overrun.

  Nearly 50 acres every hour of every day!

- Between 1970 and 1990:
  - New York's population grew 5% - land area grew 61%
  - Chicago's population grew 4% - land area grew 46%
  - Cleveland's pop. declined 11% - land area grew 33%

Over 450 square miles of agricultural and vacant land were converted to residential and employment uses, streets, and buildings

Agricultural Movement Westward



The Costs of Sprawl

- infrastructure - $750 billion
- lost time in traffic - $168 billion
- health effects and fatalities - $226 billion
- gasoline - $89 billion
- tires and parts - $34 billion
- insurance and registration fees - $26 billion
- defense costs - $50 billion
- crop losses - $5 billion

$150 billion

Sprawl fragments landscapes; disrupts habitats; alters rivers, streams, and watersheds; and increases run -off and associated flooding

Water Quality

- Each year more than 100,000 acres of wetlands are destroyed, in large part to build sprawling new developments.
- Wetlands can remove up to 90 percent of the pollutants in water.
- Wetlands destruction leads directly to polluted water.
- Sprawl increases the risk of flooding:
  - Development pressures lead to building on floodplains.
  - In the last eight years, floods in the United States killed more than 850 people and caused more than $89 billion in property damage.

The Built Environment

- A significant impact on available natural resources.
- Globally, the building industry consumes:
  - 40% of the raw stone, gravel, and sand
  - 25% of the virgin timber
- In the United States, buildings consume:
  - 31% of the total energy expended each year
  - 50% of the SO_2
  - 25% of the NO_x
  - 35% of the CO_2 produced
  - $ 210 billion for energy each year
    - $120 billion for residential
    - $90 billion for commercial buildings

Why Sustainable Design?

- Stabilize atmospheric carbon.
- Reduce global climate change impacts.
- Stretch out nonrenewable resources such as fossil fuels:
  - World oil consumption will soon surpass production.
  - In the next decade world oil production will peak.
- Improve the quality of life in our communities.
- Curtail poor air quality and ozone depletion.
- Improve water quality.
- Increase habitat and meet ecological requirements.

Who is Promoting Sustainable Design and Development?

Not a New Concept

Then I say the earth belongs to each . . . generation during its course, fully and in its own right, no generation can contract debts greater than may be paid during the course of its own existence.

Thomas Jefferson, 1789

- a fundamental characteristic?
  - the preservation of the species and the gene pool
- more recent constructs
  - an understanding that preserving our species may include the preservation of the environmental characteristics in which the human settlement exists
- an ecological construct

American Institute of Architects

In its broadest scope, sustainability refers to the ability of a society, ecosystem, or other ongoing system to continue functioning into the indefinite future, without being forced into decline through exhaustion or overloading of the key resources on which that system depends.

1. *Designing buildings* so they are minimal consumers, and may even be generators, of energy and other resources.
2. *Using building materials* that have a benign impact on the environment throughout their life cycle--in their acquisition, manufacture, placement, use, recycling, and eventual disposal.

from: The Architect's Handbook of Professional Practice,

The AIA

3. *Constructing buildings* with internal environments--air quality, lighting, spatial design, aesthetics--that are health-giving and inspiring.
4. *Arranging buildings* so they foster community, and so that most people, most of the time, can have high-quality lives--including work, residence, commerce, and community--within walking distance or cycling distance.
5. *Developing urban areas* and regions so they have natural environments--whether as parks, greenbelts, or countryside--within walking distance of every residence.
6. *Developing the infrastructure* of public transit, roads, bike paths, utilities, and communications so that community at the human scale is enhanced, variety is readily accessible, and the automobile is optional for most people, most of the time.

AIA Committee on the Environment

Architects play a unique role in decision making that affects the environment. As specifiers of building products and materials, knowledgeable practitioners influence industry and manufacturing in the development of environmentally sound alternatives.

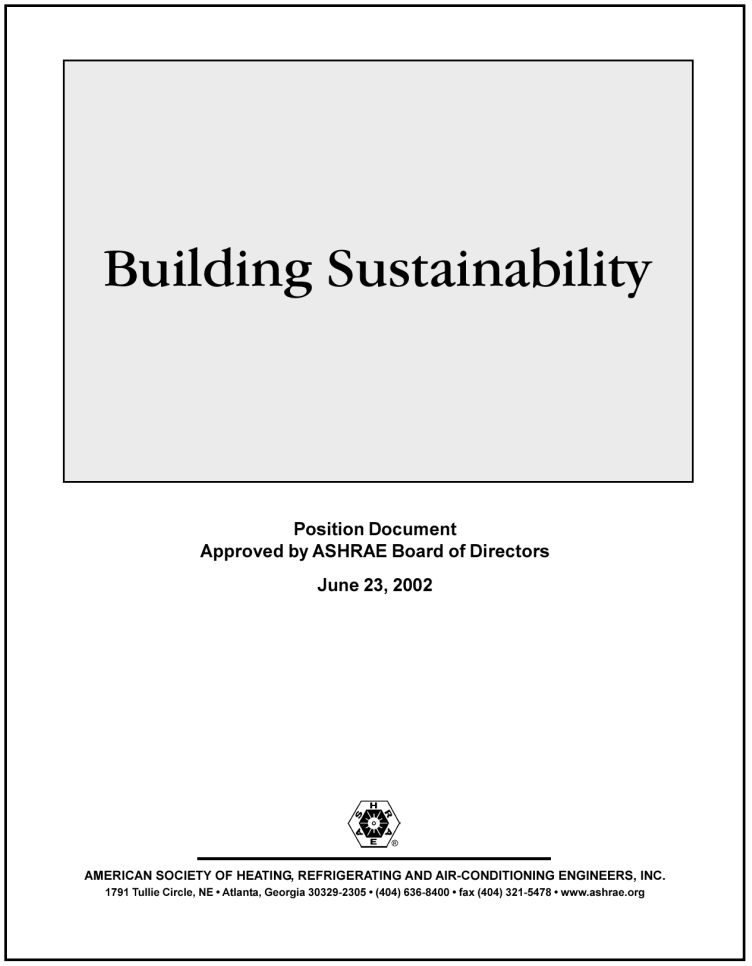
Both clients and the public look to design professionals for expertise on the interrelated application and environmental impact of design, building products, and materials.

Human health, productivity, energy efficiency, waste management, and building ecology are some of the many practice areas in which the architect's environmental role is crucial.

Knowledge and information ensure that environmental considerations are essential elements of the design process.

The American Society of Heating Refrigeration and Air-Conditioning Engineers

- ASHRAE supports building sustainability as a means to provide a safe, healthy, comfortable indoor environment while simultaneously limiting the impact on the Earth's natural resources.


Building Sustainability
Position Document
Approved by ASHRAE Board of Directors
June 23, 2002
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.
1791 Tullie Circle, NE • Atlanta, Georgia 30329-2305 • (404) 636-8400 • fax (404) 321-5478 • www.ashrae.org

The American Society of Heating Refrigeration and Air-Conditioning Engineers

- ASHRAE will use its position as the technical society recognized as the global leader in HVAC&R technologies and applications to develop and disseminate technical information, standards, educational programs and research on issues of social importance to promote building sustainability.
- Further, ASHRAE will:
  - Consider integrating building sustainability principles, effective practices and emerging concepts into all appropriate ASHRAE standards, guidelines, Handbook chapters and Society publications;
  - Actively participate with internationally recognized building sustainability groups where deemed appropriate;
  - Promote and provide education on building sustainability to its members and society through the ASHRAE Learning Institute and grassroots chapter activities.

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U.S. Green Building Council

- A consortium of public and private interests
- Vision:
- ***green buildings and communities for a healthy and prosperous planet***
  - Market Transformation (the LEED building rating system)
  - Integration and Education of Membership (website committee, ASTM green building committee, meetings/conferences)
  - Government / Industry Partnership Programs (state and local green building initiatives committee, federal government committee)

Department of Energy

- Center of Excellence for Sustainable Development
  - three pronged approach:
    - economic
    - environmental
    - cultural resources
- The DOE appears to be positioning itself as the government leader in sustainability oriented issues

"Sustainable development provides a framework under which communities can use resources efficiently, create efficient infrastructures, protect and enhance quality of life, and create new businesses to strengthen their economies. It can help us create healthy communities that can sustain our generation, as well as those that follow

Environmental Protection Agency

create full opportunity for citizens, businesses, and communities to participate in and influence the natural resource, environmental, and economic decisions that affect them

- New considerations to everyday decisions
- EnergyStar™:
  - Homes
  - Buildings
  - Materials & products
- Pollution Prevention (P2) Program
- Education and Outreach
- Challenge Grants
- Regional Strategic Plans

Executive Order 13123 Greening of the Government through Efficient Energy Management

- Requires:
  - Sustainable Design and Development.
  - Reduction in energy usage.
  - Reduction in water usage.
  - Enhance use of renewable energy.

US Army Corps of Engineers

- Definition of Sustainable Design

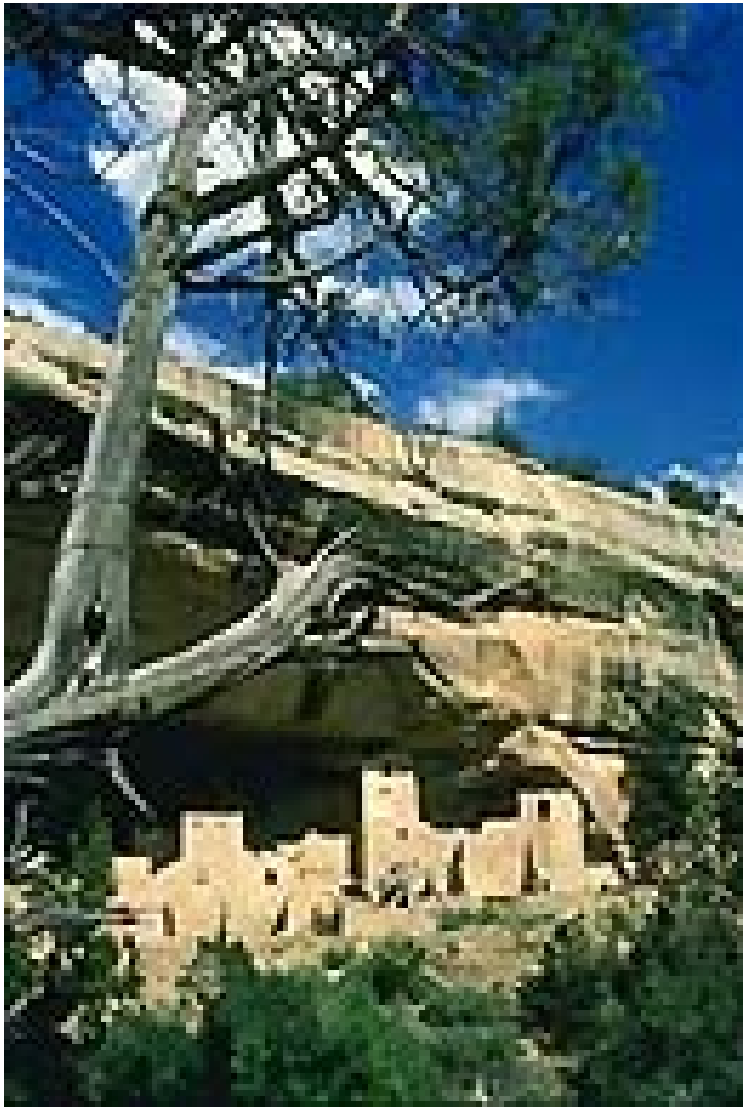
"Sustainable Design is the design, construction, operation and reuse/removal of the built environment (infrastructure as well as buildings) in an environmentally and energy efficient manner."

principles and practices to create a built environment which optimizes functionality and operability of the total system…

Where are examples of Sustainable Design?

Mesa Verde

Features:
Passive tempering with summer shading by the cliff overhang.
Built from local natural materials.
High density living.
Human scale.



Village Homes, Davis, CA

Known as the "granddaddy" of green developments. In 1995, homes sold for $10-$25 per SF over standard homes in the area. Homes have a low turnover and sell faster. Very low crime rate in neighborhood.

Lowered ambient air temperature by 15F by reducing paving. Surface drainage system saved $800 per lot, which was applied toward additional landscaping. Annual household bills range from 1/2 to 1/3 less than surrounding neighborhoods. 80% of the residents participate in neighborhood activities. Average number of cars per household is reduced from surrounding Davis neighborhoods.

Inn of the Anasazi,

Sante Fe, NM

Features: Reused a building in downtown Santa Fe. Design reflects the diverse cultures of the region. Used locally sourced, non-toxic building materials. Daylighting throughout building. Extensive community connections and involvement. Green operations and employees have paid time each week to work in the community. Seventy percent of the food is sourced from organic farms. Kitchen wastes sent to the local pig farm

Results: Appraised at $14 million. Got an offer to buy the hotel at over $14.5 million. Value increased by more than $2 million in less than 3 years. 83% average occupancy rate and 35% repeat traffic. Development team's attention to environmental and community issues has boosted the inn's and the restaurant's performance by 15-20%. Supports local organic Land Grant Hispanic

ING Bank, Amsterdam

Features: Integrated design team process. Passive solar heating and ventilation. Cogeneration and waste heat capture. Daylit office space and interior cores. Water-efficient landscaping and rainwater cisterns. Flexible and adaptable design for changing uses. Site in proximity to a majority of employees' residences. Art integrated into the design.

Results: 92% reduction in primary energy compared to conventional building of similar size. Productivity gains, absenteeism down by 15%. Bank's business has grown dramatically. Estimated energy savings of $2.9 million. Did not accurately estimate future needs of the people or plug loads (due to the rise in computer use) and went over estimated energy use. Problem corrected following analysis.

The Adam Joseph Lewis Center, Oberlin College, OH

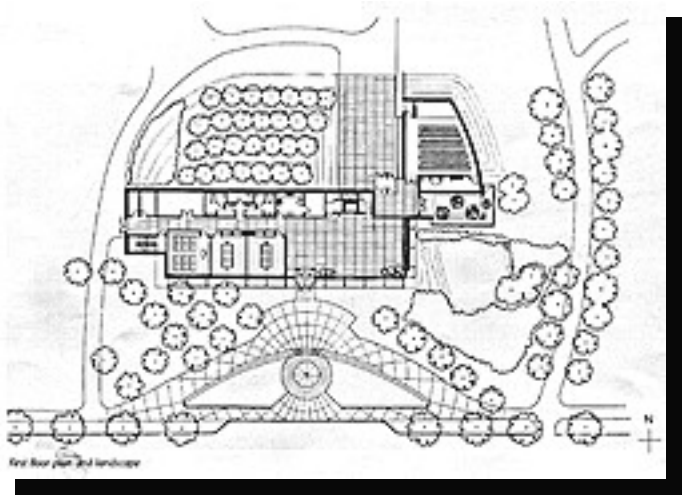
Features: Not just a place for classes but a building that would help to redefine the relationship between humankind and the environment--one that would expand our sense of ecological possibilities.

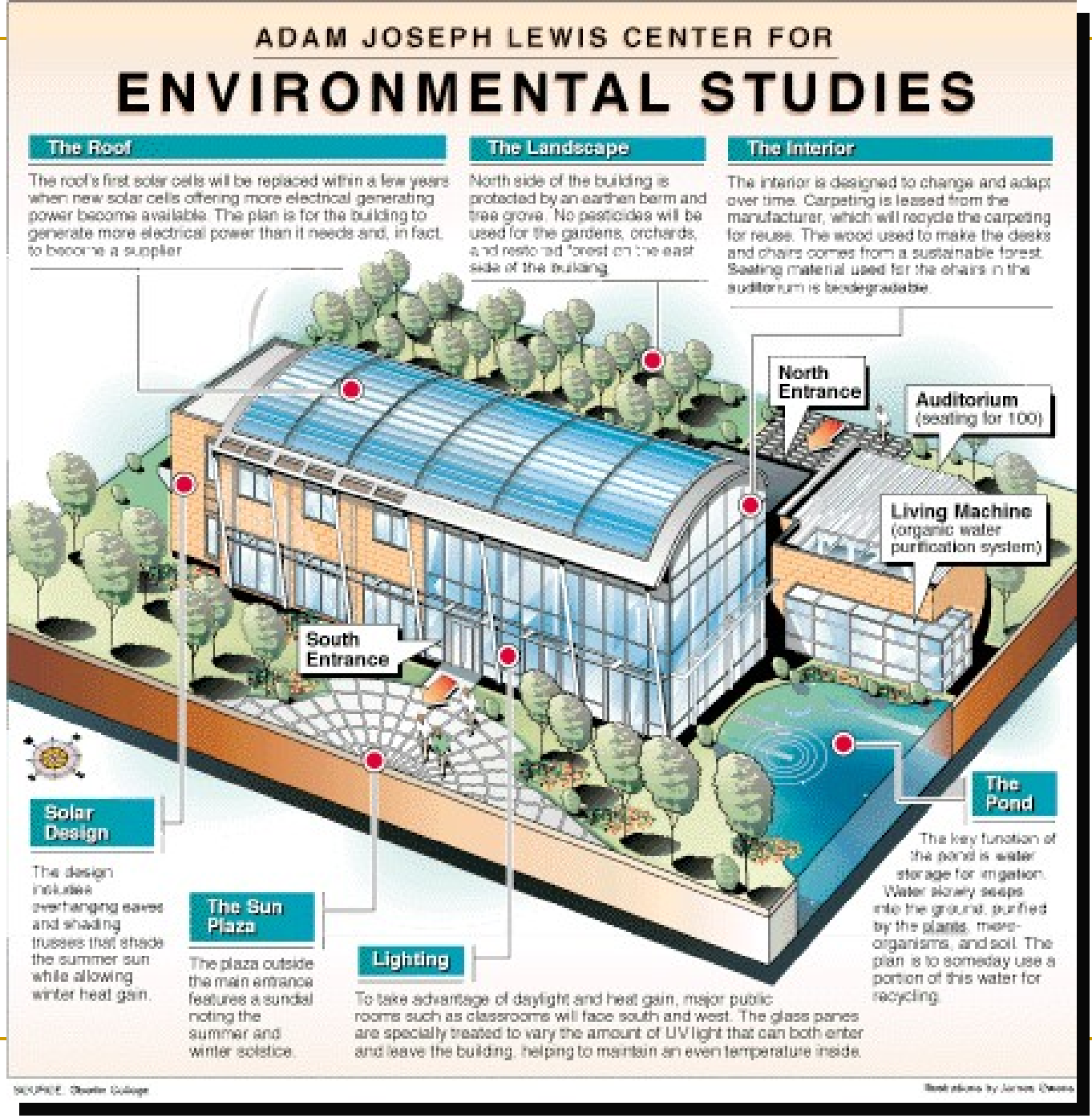
Is it possible to power buildings by current sunlight?

Is it possible to create buildings that purify wastewater?

Is it possible to build without compromising human and environmental heath?

In other words, is it possible to design buildings so well and so carefully that they




ADAM JOSEPH LEWIS CENTER FOR
ENVIRONMENTAL STUDIES
The Roof
The roof's first solar cells will be replaced within a few years when new solar cells offering more electrical generating power become available. The plan is for the building to generate more electrical power than it needs and, in fact, to become a supplier
The Landscape
North side of the building is protected by an earthen berm and tree grove. No pesticides will be used for the gardens, orchards, and restored forest on the east side of the building.
The Interior
The interior is designed to change and adapt over time. Carpeting is leased from the manufacturer, which will recycle the carpeting for reuse. The wood used to make the desks and chairs comes from a sustainable forest. Seating material used for the chairs in the auditorium is biodegradable.
North Entrance
Auditorium (seating for 100)
Living Machine (organic water purification system)
South Entrance
Solar Design
The design includes overhanging eaves and shading trusses that shade the summer sun while allowing winter heat gain.
The Sun Plaza
The plaza outside the main entrance features a sundial noting the summer and winter solstice.
Lighting
To take advantage of daylight and heat gain, major public rooms such as classrooms will face south and west. The glass panes are specially treated to vary the amount of UV light that can both enter and leave the building, helping to maintain an even temperature inside.
The Pond
The key function of the pond is water storage for irrigation. Water slowly seeps into the ground, purified by the plants, micro-organisms, and soil. The plan is to someday use a portion of this water for recycling.

Phillip Merrill Environmental Center Headquarters Annapolis, Maryland

Owner:	Chesapeake Bay Foundation	
Project Team:	Architect:	*SmithGroup, Inc.*
	Engineer:	*SmithGroup, Inc.*
	P.Manager:	*Synthesis, Inc.*
	Contractor:	*Clark Construction Group*
	Consultant:	*Janet Harrison, Architect*

Building Statistics:

Completion Date:	*November, 2000*
Cost:	*$6.36 M*
Size:	*30,600 gross square feet*
Footprint:	*12,000 square feet*
Construction Type:	*3B, Two Stories over Open Parking*
Use Group:	*Business(B), Assembly(A-3), Storage(S-2)*
Lot Size:	*33 acres*
Annual Energy Use:	*23 kBtu/sf/year*
Occupancy:	*90 Staff*

LEED™ 1.0 Certification: PLATINUM

Notes from the Project Team: *LEED™ was instrumental in conveying the importance of the sustainable elements of the design to CBF's Board of Trustees.*

- ❑ Sustainable Sites
  - **Site Selection:** *Erected in Smart Growth Funding Area on footprint of existing structure. 26.6 acres remain undisturbed in Land Trust.*
  - **Educational Model:** *Interpretive trails & demonstrations for public visitors*
  - **Storm/Waste Water:** *All Composting Toilets & Bioretention/Wetland*
  - **Resource Protection:** *Woodland, Wetland, & Tidal Water Restoration*
- ❑ Water Efficiency
  - **Water:** *Rainwater Catchment & Reuse for Hand Washing & Irrigation*
- ❑ Energy and Atmosphere
  - **Domestic Hot Water:** *Thermomax-Solar Technology*
  - **Energy:** *Exceeds ASHRAE/IES Standard 90.1-1989 by 50%*
  - **HVAC:** *Natural Ventilation and Desiccant Dehumidification & Heat Recovery*
  - **Controls/Monitoring:** *Building Energy management System, "Green Light" notifies staff to open windows when outside conditions comply*
  - **Power Source:** *30% Renewable with Geo-Exchange & Photovoltaics*
  - **Lighting:** *Daylight Harvesting and time clock lighting controls*
  - **Rapidly Renewable:** *Bamboo, cork and linoleum floorings*
  - **Recycled Content:** *Metal roofing and siding, acoustic ceiling, ceramic tile, and MDF cabinetry*
- ❑ Materials and Resources
  - **Structure:** *Rapidly Renewable-Paralam Post, Beam, and Truss system*
  - **Envelope:** *Structural Insulated Panels (SIP) R-20 walls, R-30*

Olympic Speed Skating Oval

- LEED Certified:
  - Integrated design
  - Low budget ($27M)
- Suspended roof:
  - Lower volume
  - Lower overall cost
  - Better conditioning
  - Lower energy
  - High albedo

Ecotrust Natural Capital Center

- LEED Gold – historical building adaptive reuse

Site: Green roof, transit access, 50 bicycle parking spaces and showers, car-sharing

Indoor Environmental Quality: Low-VOC materials

Energy Use: High-efficiency windows, fixtures and HVAC system (30% energy savings!)

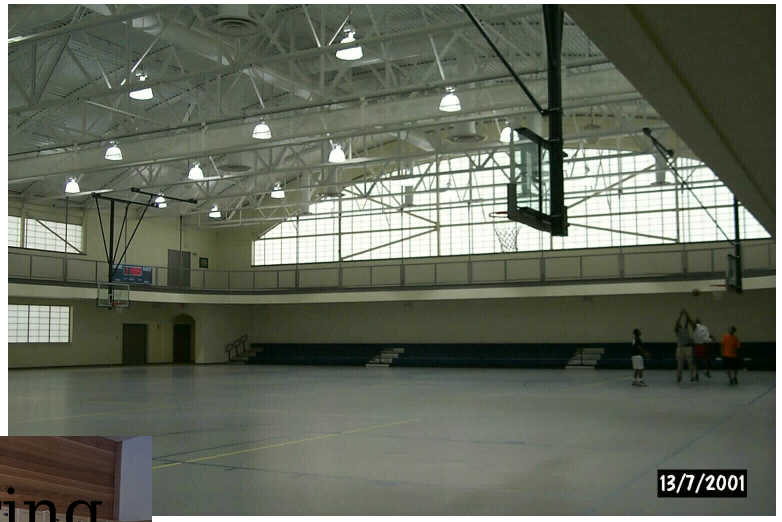
State of Pennsylvania - Cambria Office Building

- LEED Gold Rating:
  - 50% energy savings
  - Renewable energy
  - Low emitting materials
  - Daylighting
  - Water efficient (-30%)
  - Controllability of systems

Barksdale AFB Physical Fitness Center

- First USAF project certified.
- Goals:
  - Maintain schedule to award in the year of appropriation (FY 98).
  - Maintain the existing scope (4425 SM) and budget (PA $9.3M).
  - Obtain a Bronze LEED rating (22 points minimum).
  - Use Best Value Source Selection procurement.

Fitness Center BAFB



Recycled Rubber Flooring

Recycled Plastic Lockers

Compact Fluorescen

Fitness Center BAFB

Natural Lighting

Low VOC Paints, Adhesives, Sealants

Recycled Content Carpet

Fitness Center BAFB

Shaded Windows
Reflective Roof

Reflective Parking Surface

Natural Grasses,

Alternative Transportation

Fitness Center BAFB

- Sustainable Features:
  - Reduced heat islands: reflective parking surface and trees planted to shade parking areas
  - Efficient location: close to bus lines and community housing areas
  - Alternative transportation: Bicycle racks and shower/changing facilities; electric vehicle station
  - Building commissioning: verification of design intent
  - Energy efficiency: heat recovery and high efficiency
  - Recycled building content materials: focus on recycled content materials: tracking of material content

Fitness Center BAFB

- Sustainable features:
  - Construction waste management: 75% diversion of C&D from landfill
  - Indoor air quality: low VOC paints, adhesives, sealants
  - Water conservation: low flow fixtures
  - Water recovery: rainwater harvesting and reuse for flushing toilets and urinals (40,0000 gal/month)
  - Water efficient landscape: use of natural grasses and landscape plantings – no irrigation

Central Supply Facility – Argonne National Laboratory

- **Key Sustainable Design Features of Project:**
  - Fly ash aggregate in concrete
  - Recycled concrete block
  - Pulverizing and reuse of existing gravel asphalt & sub-base.

Central Supply Facility

- Reuse of existing excavated soil
- Recycled concrete curbs
- Native trees
- Native grass seed
- Roof drainage into existing wetland
- Recycled structural steel
- Recycled sustainable lumber
- Natural linoleum floor
- Recycled content carpeting
- White roof
- Low VOC and lead free paints
- Recycled content ceiling tiles
- Recycled plastic toilet dividers

Central Supply Facility

- Gypsum Board with recycled content
- High performance windows selective to West and North
- Clerestory windows
- Energy efficient Mechanical and Electrical systems
- Construction site recycling
- Building Commissioning

Central Supply Facility, LEED Project # 0323

LEED Version 2.0 Certification Level: SILVER

November 21, 2002

36 Points Achieved — Possible Points: **69**

Certified 26 to 32 points Silver 33 to 38 points Gold 39 to 51 points Platinum 52 or more points

9 Sustainable Sites — Possible Points: 14

Y			
Y	Prereq 1	**Erosion & Sedimentation Control**	
1	Credit 1	**Site Selection**	1
	Credit 2	**Urban Redevelopment**	1
	Credit 3	**Brownfield Redevelopment**	1
1	Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1	Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Refueling Stations	1
	Credit 4.4	**Alternative Transportation**, Parking Capacity	1
1	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
1	Credit 6.2	**Stormwater Management**, Treatment	1
	Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
	Credit 8	**Light Pollution Reduction**	1

4 Water Efficiency — Possible Points: 5

Y			
1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
	Credit 2	**Innovative Wastewater Technologies**	1
1	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

6 Energy & Atmosphere — Possible Points: 17

Y			
Y	Prereq 1	**Fundamental Building Systems Commissioning**	
Y	Prereq 2	**Minimum Energy Performance**	
Y	Prereq 3	**CFC Reduction in HVAC&R Equipment**	
2	Credit 1.1	**Optimize Energy Performance**, 20% New / 10% Existing	2
2	Credit 1.2	**Optimize Energy Performance**, 30% New / 20% Existing	2
	Credit 1.3	**Optimize Energy Performance**, 40% New / 30% Existing	2
	Credit 1.4	**Optimize Energy Performance**, 50% New / 40% Existing	2
	Credit 1.5	**Optimize Energy Performance**, 60% New / 50% Existing	2
	Credit 2.1	**Renewable Energy**, 5%	1
	Credit 2.2	**Renewable Energy**, 10%	1
	Credit 2.3	**Renewable Energy**, 20%	1
1	Credit 3	**Additional Commissioning**	1
	Credit 4	**Ozone Depletion**	1
1	Credit 5	**Measurement & Verification**	1
	Credit 6	**Green Power**	1

5 Materials & Resources — Possible Points: 13

Y			
Y	Prereq 1	**Storage & Collection of Recyclables**	
	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
	Credit 1.2	**Building Reuse**, Maintain 100% of Existing Shell	1
	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
1	Credit 2.2	**Construction Waste Management**, Divert 75%	1
	Credit 3.1	**Resource Reuse**, Specify 5%	1
	Credit 3.2	**Resource Reuse**, Specify 10%	1
1	Credit 4.1	**Recycled Content**, Specify 25%	1
	Credit 4.2	**Recycled Content**, Specify 50%	1
1	Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
	Credit 6	**Rapidly Renewable Materials**	1
	Credit 7	**Certified Wood**	1

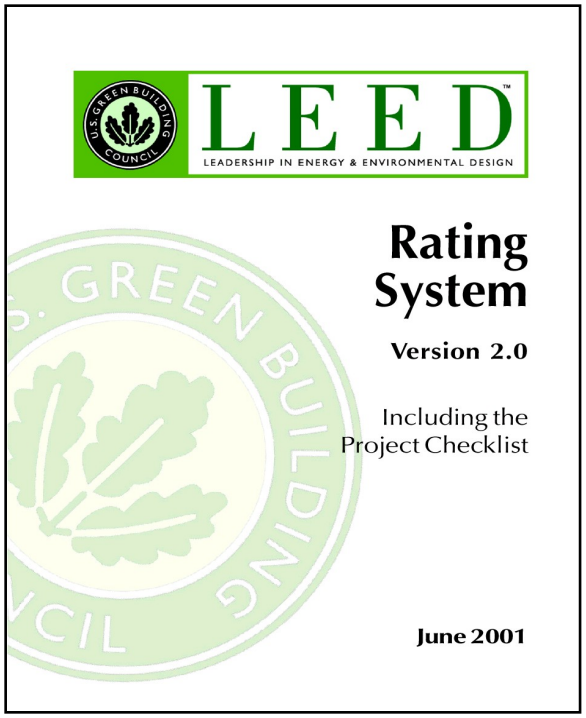
7 Indoor Environmental Quality — Possible Points: 15

Y			
Y	Prereq 1	**Minimum IAQ Performance**	
Y	Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	
	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
	Credit 2	**Increase Ventilation Effectiveness**	1
	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1	Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1	Credit 4.2	**Low-Emitting Materials**, Paints	1
1	Credit 4.3	**Low-Emitting Materials**, Carpet	1
	Credit 4.4	**Low-Emitting Materials**, Composite Wood	1
1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1	Credit 6.1	**Controllability of Systems**, Perimeter	1
	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
1	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
	Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
1	Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

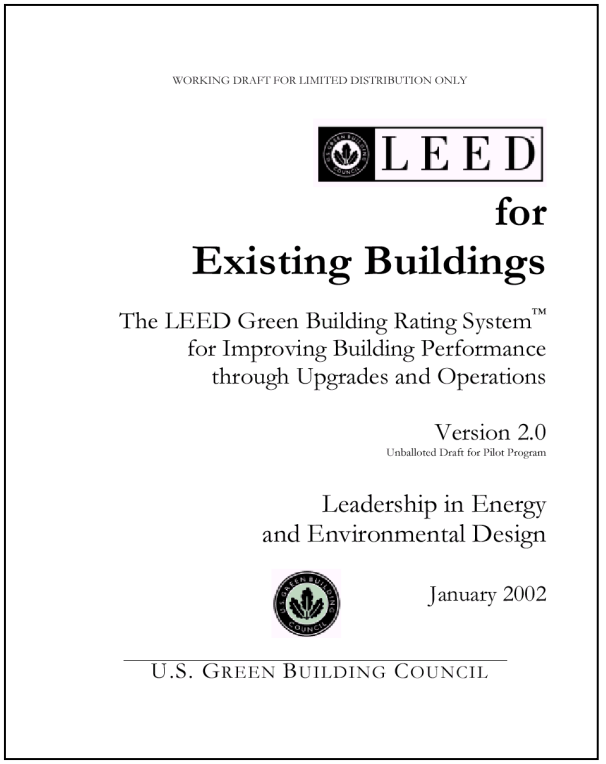
5 Innovation & Design Process — Possible Points: 5

Y			
1	Credit 1.1	**Innovation in Design**: Building Downsizing	1
1	Credit 1.2	**Innovation in Design**: Ergonomic Conveyor System	1
1	Credit 1.3	**Innovation in Design**: Exemplary Local Manufactured Materials	1
1	Credit 1.4	**Innovation in Design:** Exemplary Local Harvested Materials	1
1	Credit 2	**LEED™ Accredited Professional**	1

How can Sustainable Design ideas be incorporated?



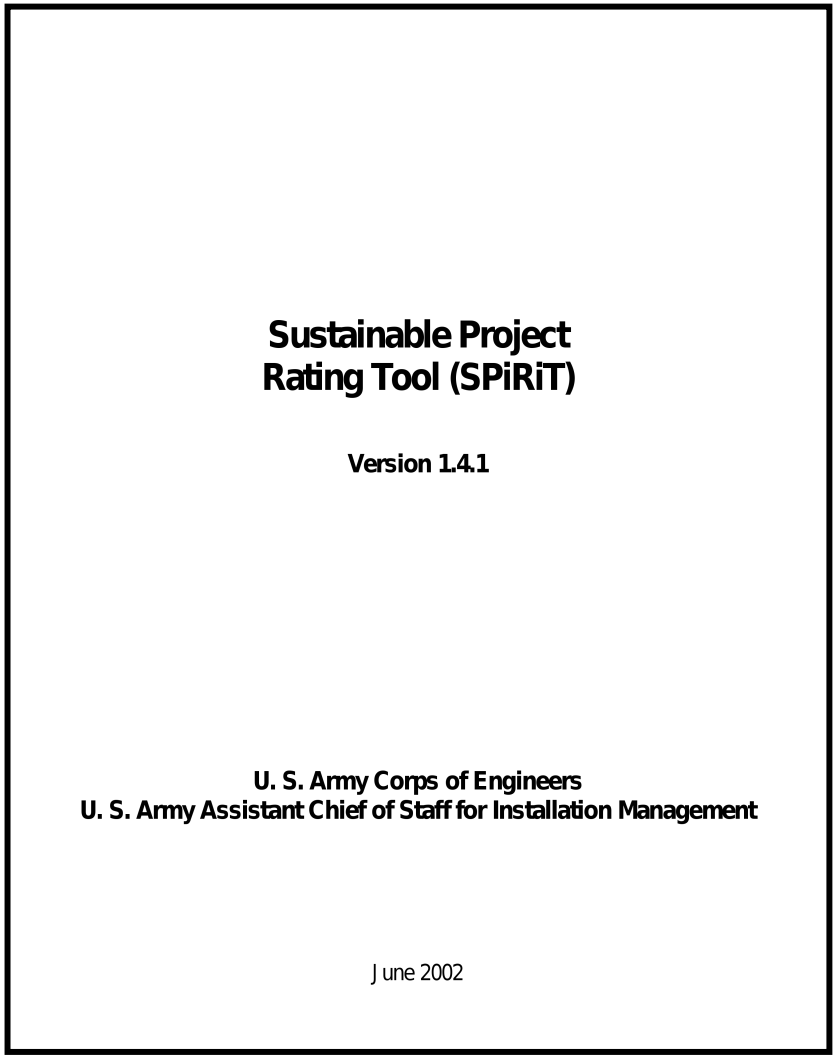
Leadership in Energy & Environmental Design



A leading-edge system for designing, constructing, and certifying the world's greenest buildings.

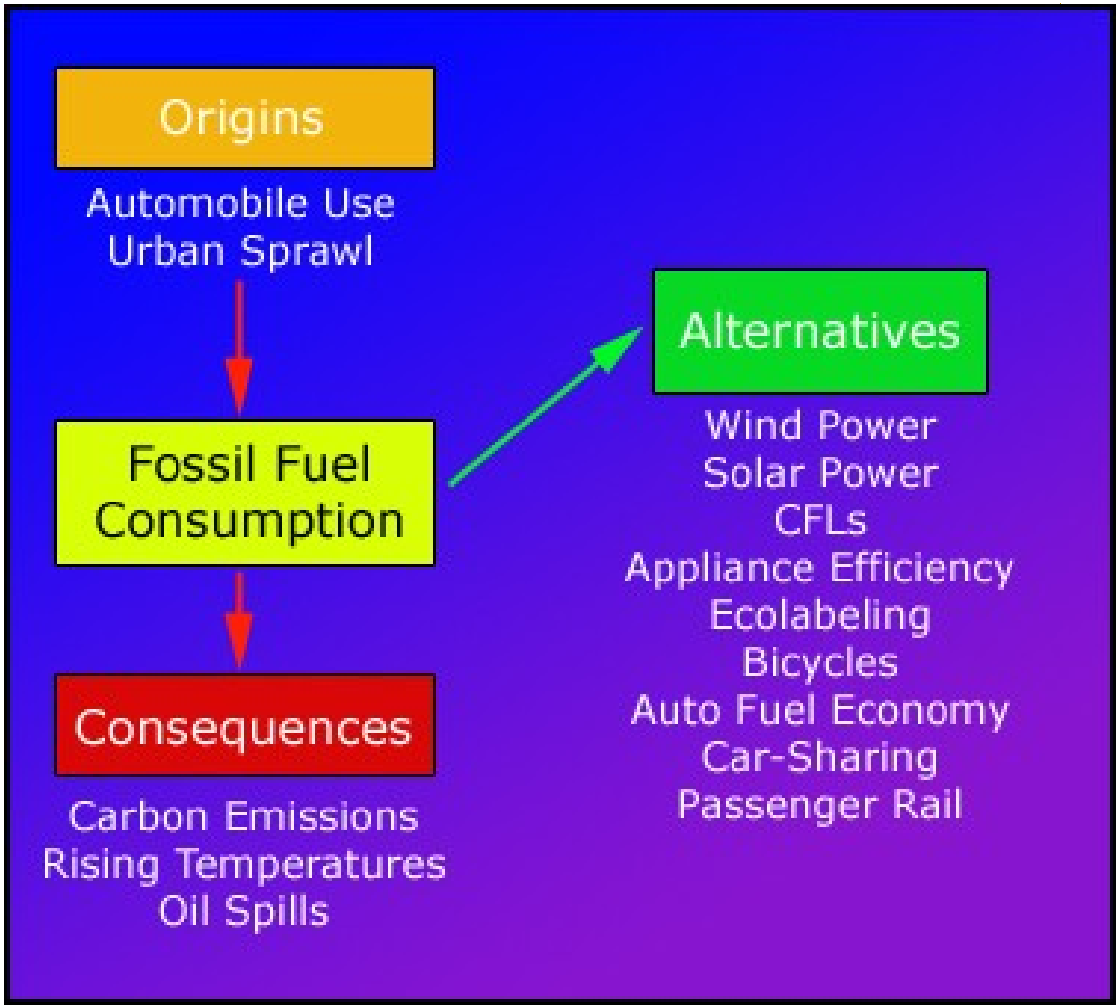
Sustainable Project Rating Tool (SPiRiT)

- Army has legal agreement with USGBC to use.
- Based on LEED2.0
- Interim guidance to meet Army's requirements.

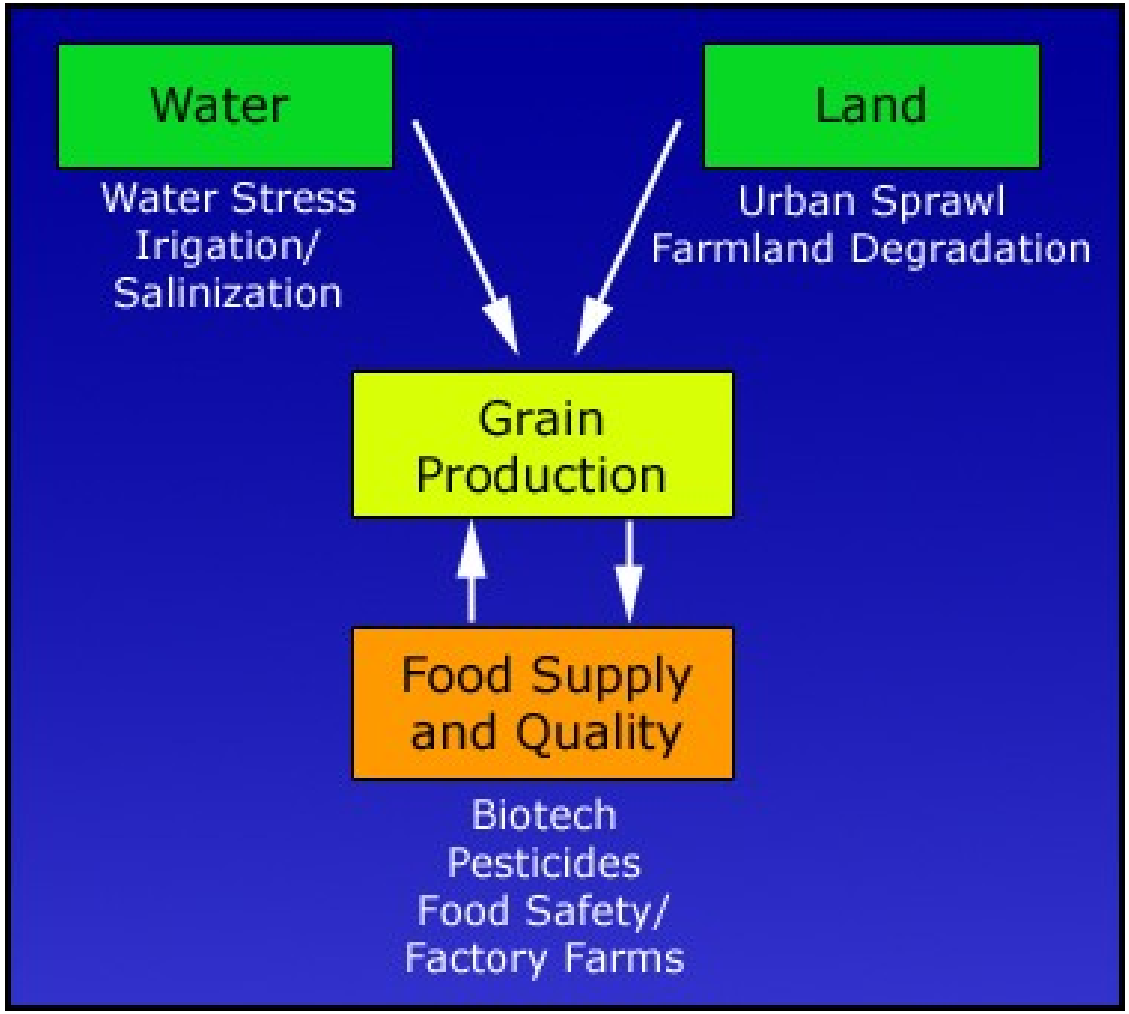

Sustainable Project
Rating Tool (SPiRiT)
Version 1.4.1
U. S. Army Corps of Engineers
U. S. Army Assistant Chief of Staff for Installation Management
June 2002

Making the Connections

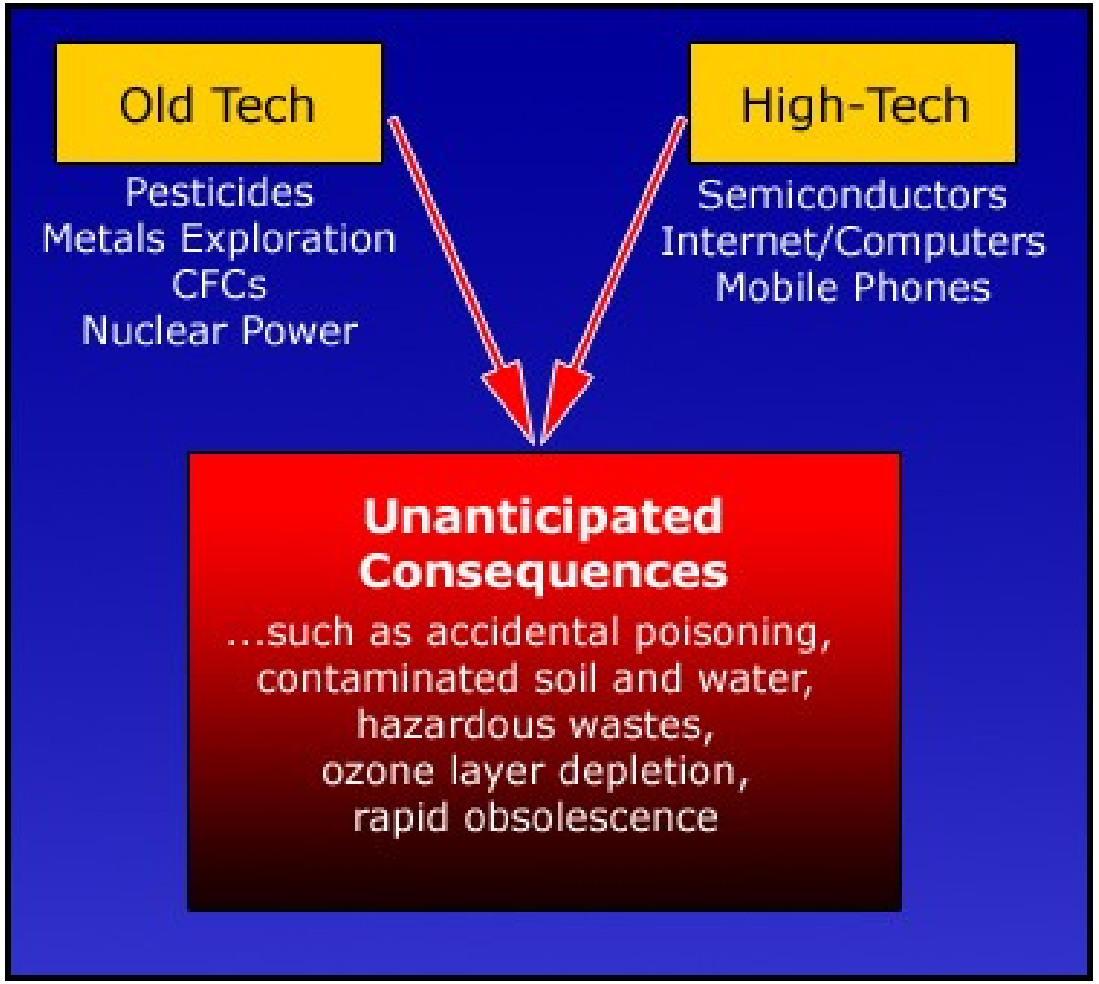
Energy, Climate, and Transportation Connections



Land, Food, and Water Connections



High Tech and Old Tech Connections



What is Sustainable Design?

Sustainable Design Includes More..

adaptive reuse

sustainable communities

productivity

social justice

water quality

preservation

quality of life

restoration

pollution prevention

water quantity

reduced infrastructure

energy supply and production

environmental equity

sprawl

habitat protection

community energy consumption

....an Ethos

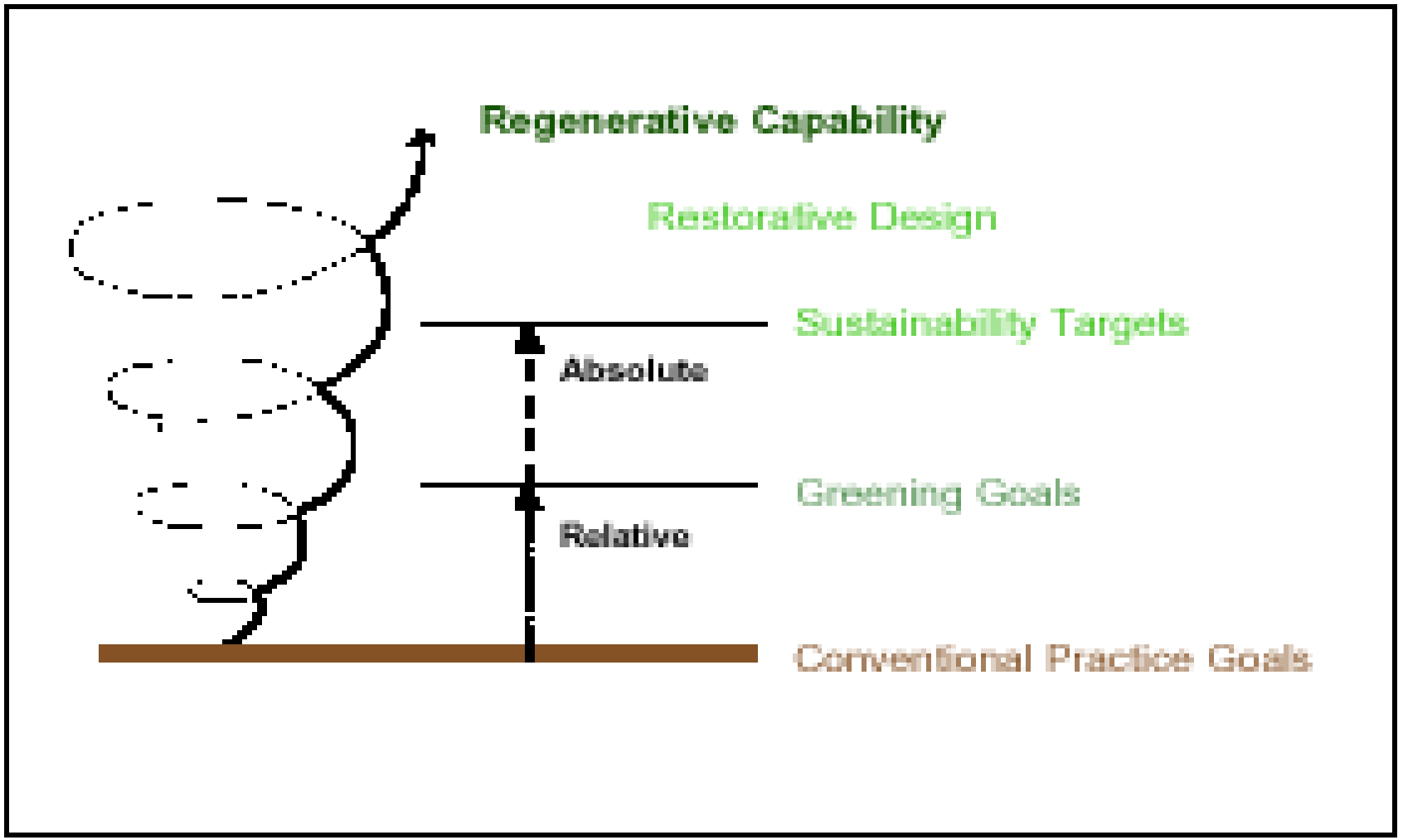
Sustainability Defined?

Requires personal definition...

.....is a self supporting, endurable quality. From a historical standpoint it may mean a continued existence through the passage of time.

.....it implies a living system (or community of systems) that exists holistically with nature, minimizing environmental and ecological degradation.

How far can we go?



Building Capacity – not Things

An Ethos

"All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts... That man is, in fact, only a member of a biotic team is shown by an ecological interpretation of history. Many historical events, hitherto explained solely in terms of human enterprise, were actually biotic interactions between people and land....Is history taught in this spirit? It will be, once the concept of land as a community really penetrates intellectual life."

Aldo Leopold, 'A Sand County Almanac'